Gas Journal

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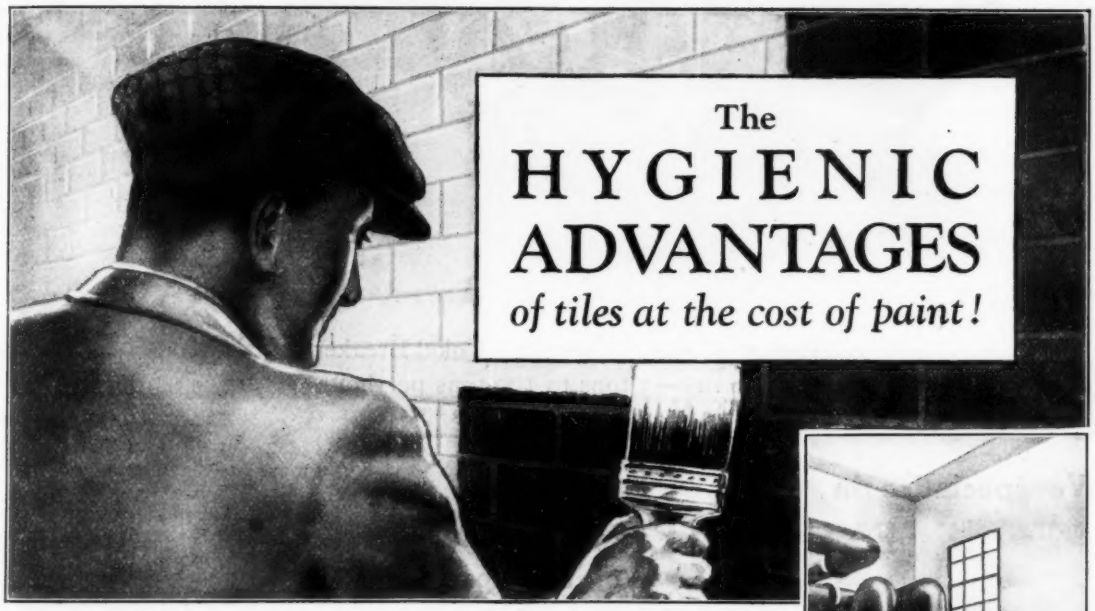

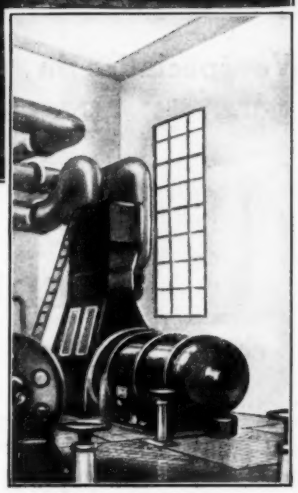

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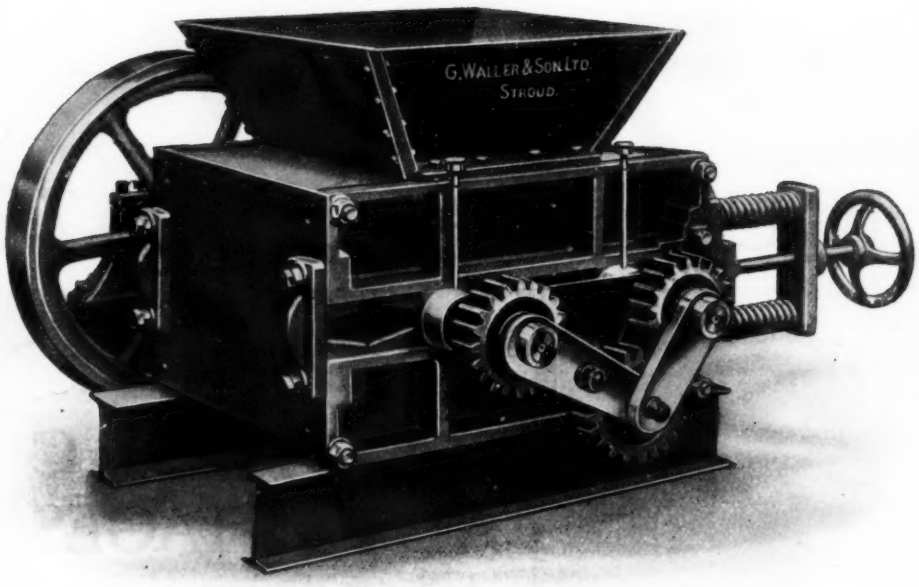

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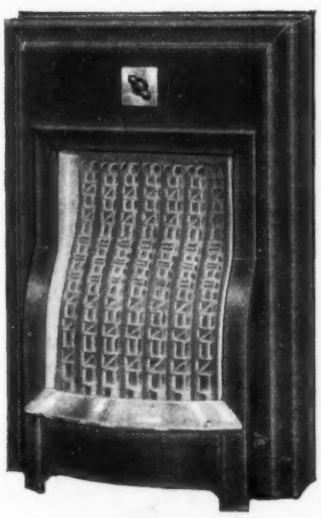

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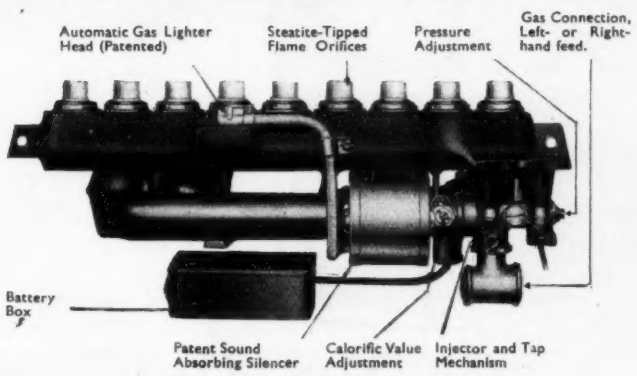

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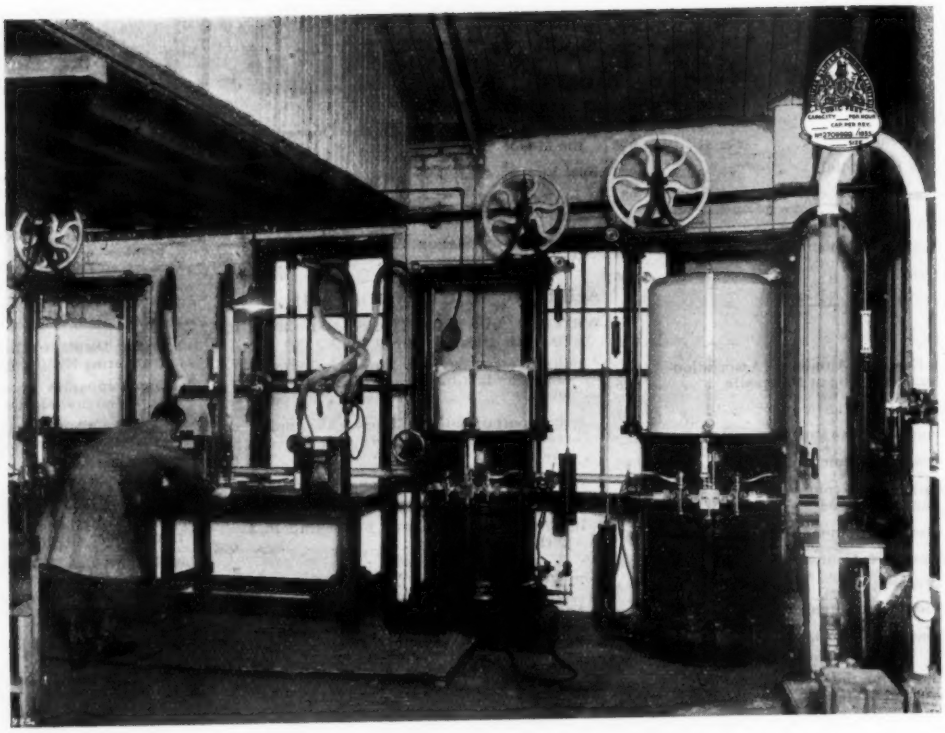

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Gas Journal

DECEMBER 4, 1935

Vol. 212. 87th Year No. 3785

Editorial Notes

Hydrogenation

We publish to-day a Paper on the Billingham hydrogenation plant of Imperial Chemical Industries, Ltd., which Mr. Kenneth Gordon presented at a meeting of the Institute of Fuel on Nov. 22. The account summarizes the history of the development of the process by I.C.I. and gives a picture of the present position. The Billingham plant is an outstanding chemical-engineering achievement upon which all concerned with its building are to be wholeheartedly congratulated. The capital expenditure entailed has been a matter of £5,500,000, and the capacity of the plant is 150,000 tons per year of petrol. Of the total flowsheet output, approximately 10,000 tons is derived from low-temperature tar, 40,000 tons from creosote oil, and 100,000 tons from coal. Hydrogenation of oil in the vapour-phase units commenced in February last, and production has continued without interruption from that time. In regard to the liquid-phase units, coal was injected for the first time last June, and since then the output has steadily increased in spite of interruptions from time to time to make minor modifications. It is anticipated that full flowsheet output will be attained before the end of the year.

Until the plant has been running at capacity for some time it is unfair to ask for any accurate costs of petrol production, though we suggest that perhaps Mr. Gordon might have given an indication of the economics of oil hydrogenation based on six months' working of that particular phase of the scheme. However, the important point is that the process is a success technically and an important National asset in the event of our being involved in another war. Moreover, it has an important bearing on the unemployment problem. At present the over-all raw coal consumption at Billingham for the 100,000 tons per year of petrol made from coal is 500,000 tons—5 tons of coal for one of petrol. A further 100,000 tons per year of coal is used in making the hydrogen and power required for the hydrogenation of creosote oil and tar, so that, at capacity, the additional coal consumption due to the petrol plant is 600,000 tons a year. Broadly speaking, therefore, for every ton of coal employed for the process the yield of petrol is in the neighbourhood of 60 gallons only—and there are no by-products. It is arguable whether this is a remarkable achievement in view of the possibilities of producing petrol from coal in other ways; and in the interests of the economic and scientific treatment of coal it is more than desirable that salient facts such as these should be borne in mind. It is essential that we should maintain a sense of proportion in assessing the contribution made by the Billingham enterprise towards the solution of the "oil from coal" problem.

Facts to Remember

We ask—and, we think, with justification—that amid all the publicity, all the sound and fury, surrounding the coal hydrogenation plan the contribution of the carbonizing industries in producing oil from coal and also raw products which can be converted into explosives should not be allowed to escape the public mind. The Billingham plant has a capacity of 45,000,000 gallons of petrol. The carbonizing industries produce—and, be it noted as a minor by-product—about 40,000,000 gallons of benzole a year, which is largely used as a motor spirit, and as far as the Gas Industry is concerned it could well produce a greater yield than it does to-day. Again, from the distillation of tar made by the carbonizing industries some 80,000,000 gallons of creosote are produced annually, which, if needed, could be readily hydrogenated to yield approximately an equal volume of motor spirit. And also, if needs be, the amount of creosote produced could be greatly increased. At the same time, these products are made in a composite process giving gas and smokeless solid fuel and having a thermal efficiency of round about 85%, compared with a thermal efficiency of 40% in the coal hydrogenation process. And in this connection we call attention to a significant passage in a contribution made by Dr. Sinnatt, Director of Fuel Research, at the National Coal Convention, and an extract of which appears in our issue to-day. The hydrogenation process, he observes, is one of the latest methods by which oil can be produced from coal. It is unique in that it is, or can be, a self-contained industry, turning coal into oil almost without residue or by-products. But this must not be allowed to over-shadow other established methods, since they in their turn may be modified by the hydrogenation technique.

We have been at pains to keep our readers thoroughly well informed of developments in hydrogenation technique and practice, and on later pages will be found an article in which the author, Herr Dipl.Ing. Laupichler,

considers the economics of the production of petrol from tars. The main point is that only protective measures of the Governments of the various countries keep hydrogenation alive. The cost figures given by Herr Laupichler, though relating to economic conditions in Germany, will, we feel sure, arouse great interest in this country.

Steaming in Horizontals

A YEAR ago—"JOURNAL" for Nov. 28, 1934—we discussed in these columns the question of steaming the free space in horizontal retorts, with reference particularly to the 1934 Report of the Fuel Research Board. Work on this problem at the Fuel Research Station was initiated at the suggestion of Mr. Madden, of Cardiff, and has been of great value. It was reported last year that at the Fuel Research Station, employing normal horizontal retorts with 12 cwt. charges, it was possible to introduce steam over the last three hours without marked influence on combustion chamber temperature. The result was to increase the yield of gas from 75 to 87 therms per ton without employing special methods of charging. At the time, mention was also made of the investigations of the Gas Light and Coke Company, the Wandsworth Company, and Cardiff into the matter. The 1935 Report of the Fuel Research Board, which has just been published, includes an account of the work on steaming which has been continued at the Fuel Research Station with a view to obtaining further data on the amount of steam decomposed, and to ascertaining the effects of various amounts of steaming. Mention is made of the fact that the Wandsworth Company has extended the use of steaming in horizontals to works carbonizing in all 800 tons of coal a day. Satisfactory results are reported, the increased gas yield of 7 to 8 therms referred to in our columns for Nov. 28, 1934, having been maintained.

Coincident with the publication of the Report of the Fuel Research Board was the very important Paper on "Steaming in Horizontal Retorts" which Mr. G. L. Braidwood, of the Gas Light and Coke Company, presented to the Southern Association of Gas Engineers and Managers on Friday last. Mr. Braidwood gives the results of extensive steaming at the Beckton Gas-Works from the end of 1933 to the present time. Two working schedules are dealt with—12-hour carbonizing period with 3 hours' steaming (combustion chamber temperature 1,360° C.); and 10-hour carbonizing period with 2 hours' steaming (*a*) with a combustion chamber temperature of 1,370° C., and (*b*) with a combustion chamber temperature of 1,380° C. Under the conditions of operation at Beckton—and this must be borne in mind throughout consideration of Mr. Braidwood's Paper—steaming on the 12-hour duration resulted in a gain of 7 therms per ton of coal carbonized, but a decrease of 11% in the daily make of therms. This is largely influenced by the fact that at Beckton, where the projector belt type of charging machine is employed, the weight of charge had to be reduced to allow of a gas-way for the steam along the free space of the retort. This, coupled with the fact that at the time of steam admission practically all the gas has been evolved from the coal, greatly reduces the throughput of the retorts. Steam will virtually not travel along the length of the retort unless there is a gas-way, and the results of the tests made at the Fuel Research Station are, the author suggests, necessarily affected by the charging machine used—a Guest-Gibbons—which lays an even charge with a gas-way. On 10-hour duration at Beckton the gain with steaming was 4 therms per ton with a combustion chamber temperature of 1,370° C. and 5 therms per ton with a combustion chamber temperature of 1,380° C. Here again the daily make of therms per retort was adversely affected.

Economics of the Process

TURNING to the economics of the process, we would again emphasize that the particular circumstances at Beckton must be remembered. Briefly stated, with normal carbonizing on a 10-hour schedule the cost per therm of unpurified gas works out at 1·06d. With a 12-hour period and 3 hours' steaming the cost per therm is given as 1·36d.; on 10-hour work with 2 hours' steaming as 1·35d. Mr. Braidwood expresses the hope that his Paper will not be interpreted as a pessimistic review of difficulties which have had to be overcome, or calculated to act as a deterrent to others who are contemplating adoption of the process of steaming in horizontals. At some works there may well be, fortuitously, a particular combination of circumstances which will contribute to a high measure of success. The author makes it clear, too, that expectations at Beckton have not yet been fully realized, that nothing approaching finality has been reached in the experiment, that at the present time the most promising stage of the investigation has been reached, and that it is hoped further to improve results in the near future. In the meantime, apart from economic considerations, Mr. Braidwood's Paper will serve as a most useful practical guide, indicating to those thinking of adopting steaming some of the factors which have to be considered.

In this connection it will be of service, perhaps, if we refer to one or two of the conclusions drawn from the experience at Beckton. The first is, as we have indicated in the foregoing, that the type of charging machine is of great importance and of all the retort house plant probably has the greatest influence on the conditions favourable to good results. With steaming, combustion chamber temperatures will have to be raised unless the carbonizing duration is increased, because it is necessary to have a fairly complete burn-off by the time steam is introduced. Scurf plays an important part in reacting with the steam and is instrumental in saving a further loss of coke. It will, states Mr. Braidwood, probably be most efficacious to double, if not treble, the normal period between scurfings. The steam itself should be superheated, and the pipeline, services, &c., lagged as far as possible. As for the retorts, these should be kept as tight as possible and conditions of pressure avoided, and the question arises as to where is the economic dividing line between loss due to overcracking of the gases and the gain from the steam decomposition under conditions necessarily conducive to both. The quality of coal carbonized has an unquestionable influence on the steaming efficiency, and wide variations in performance have been noted at Beckton. As a generalization, first-class gas-making coals give the greatest increase in thermal yield when steamed. In the Beckton experiments the percentage of steam decomposed was comparatively small, varying from 16 to 28% of the input, and unconverted steam reduced the liquor strength at the condenser seal pot from 7·2 to 4·4 oz. The quantity of sulphur in the steamed gas was somewhat higher than normal, and with steaming there was an increase of the free carbon in the tar. Such, then, are among the main conclusions drawn from the Beckton investigation.

The influence of steaming on the possibilities and economics of benzole recovery is considered generally by Mr. Braidwood, and he maintains that it should not be assumed that, because steaming is being practised, benzole washing may not also be adopted with advantage in given circumstances. As an instance he remarks that a coal gas of 540 B.Th.U. quality can be steamed down to 500 and then further stripped to give a works outlet calorific value of 470 or 460 B.Th.U., the extra therms resulting from the steaming more than compensating for those lost by stripping, though at a lower calorific value.

Also, he says, the former process will be instrumental in increasing the profit from the sale of spirit, which in the first instance must include the cost of replacing therms so lost. Where benzole stripping is out of the question, steaming of horizontals is likely to prove of benefit as a diluent. It may also prove convenient as a substitute for a carburetted water gas plant, but only where this is used as a means of reducing calorific value and not where it is considered as an auxiliary gas-making plant.

Conflicting Views

THE Paper led to lengthy and informative discussion, Mr. Townsend, of Colchester, Mr. Langford, of Tunbridge Wells, Mr. Gray, of Wandsworth, and Mr. Miller, of Walton-on-Thames, relating their experiences of steaming horizontals and expressing their satisfaction with the results achieved. The whole idea, however, was condemned by Mr. Parrish, of the South Metropolitan Gas Company, to whom the plan of decreasing throughput, increasing cost per therm, increasing the volume of liquor made, and also the free carbon content of the tar, has precisely no appeal whatever. However, he said, the author and his Company are to be congratulated on the clarity and signal honesty with which they have presented the detailed figures arising from the investigation, and particularly on the provision of a financial statement without which a true perspective would be impossible. It would be well, added Mr. Parrish, if the Fuel Research Board would follow the example and allow their technical results in future to be accompanied by a financial statement, in order that the implications of any parallel investigations might be adequately appreciated. Captain Fraser-Shaw, of the Fuel Research Station, decidedly disagrees with the views of Mr. Parrish on the process of steaming in horizontals, and he explained to the meeting some of the advances which have been made lately in the investigation being carried out by the Fuel Research Boad. He suggested that the therm resulting from steaming is practically something for nothing. As to the efficiency of steam decomposition, he mentioned that an average figure of 54% had been obtained at the Station, and he advised an increase in the volume of the heating gases around the retorts and the use of a poorer producer gas. The Paper and our report of the discussion, published in our issue to-day, will prove of the utmost service. To steam or not to steam? The answer to the question will obviously be governed by local circumstances. There is certainly no general reply.

Eastbourne Secures Justice

THE Eastbourne Gas Company are to be congratulated on the judgment which they obtained on Nov. 26 from the Chancery Division of the High Court in their action against the Eastbourne Corporation. The effect of the decision is that it will no longer be possible for electricity undertakers, whether company or municipal, so to fix their charges as to penalize gas consumers.

The facts of the Eastbourne case are simple. The Corporation offered by circular to supply electricity at especially attractive rates "for all-electric or coal-electric domestic premises." To the unwary the meaning of the term "coal-electric" domestic premises may not be obvious, but in order that no doubt should exist it was carefully explained in the circular that the tariff was "available only to consumers who use electricity for cooking or water heating, and apart from coal or coke do not use any other medium of lighting, heating, cooking, or water heating." Reducing this to plain English, the housewife who cooked on a coal range could have her electricity cheap, but she could not if she cooked by gas.

There could never have been much doubt that a tariff framed on these lines was contrary to the provisions against undue preference which apply to all authorized electricity undertakers. Those provisions are contained in the Electric Lighting Act, 1882 (Section 20), which states that "the Undertakers shall not, in making any agreements for a supply of electricity, show any undue preference to any local Authority, Company, or person."

So long ago as 1915 the Long Eaton Gas Company obtained a judicial construction of this section from the Courts. Mr. Justice Sargent (as he then was) dealt with the question of undue preference as follows: "I think a fairly clear distinction may be drawn for the present purpose between those reasons for making a lower or preferential charge which under legislation of this kind are legitimate and those which are illegitimate. It would seem that A must not be charged less than B merely to overcome a greater reluctance on the part of A to become a customer, or to induce A to become a customer in respect of another supply, although either of these reasons might be a good commercial reason for charging less to A were the public undertakers merely carrying on any ordinary commercial business. On the other hand, any circumstances which render it less costly or otherwise more profitable to supply A than B constitute a legitimate reason for making a lower charge to A for the same supply."

Applying these words to the case at Eastbourne, it could scarcely be contended that the fact that a consumer who uses coal for heating or cooking as distinct from gas is a circumstance which renders the supply of electricity to such a consumer "less costly, or more profitable" to the electricity undertakers. The sole object of the tariff was, of course, to induce the consumer not to use gas. It is hardly surprising that the case was not contested by the Eastbourne Corporation, who submitted to the making of a declaration that the tariff in question was in contravention of the Electric Lighting Acts.

On the broader aspect, the case is not dissimilar in some respects from the position at York, upon which we commented recently. Both cases indicate the attack which too many Local Authorities owning electricity undertakings appear to feel it necessary to make upon the Gas Industry. The two other principal weapons in this attack are, first, the exercise by Local Authorities of their powers as a Housing Authority to push the sale of electricity, as is the case at York; and, secondly, the framing of tariffs designed to prejudice gas consumers who desire electricity for certain purposes. That such attacks should be made indicates a total failure to appreciate the function of a public utility undertaking, which is to supply its commodity cheaply and efficiently to the public. It is not, as Mr. Justice Sargent in the judgment cited above points out, to be governed by considerations which would be natural to an ordinary commercial organization. Both gas and electricity undertakings are authorized by Parliament to supply the inhabitants of certain specified areas with their commodity, and the public are given statutory rights to demand a supply.

Is it too much to hope that in the not far distant future municipal electricity committees will realize that the policy of "a fair field and no favour" between the rival services of gas and electricity is that which will tend to secure the best service to the community as a whole? An appreciation of this fact at least on the part of the Eastbourne Gas Company is shown by a splendid peace-making gesture. In the same issue of the *Eastbourne Gazette* which reported the High Court judgment there appeared a letter over the signature of Mr. Sydney E. Knowles, the General Manager and

Secretary, in which he clearly set out the standpoint of the Gas Undertaking, and the service they had rendered to the citizens of Eastbourne in ensuring that any person shall be free to use gas for any purpose without the risk of being penalized thereby. Mr. Knowles' letter then concludes with the following appeal: "My Board, therefore, sincerely trusts that, the air having been cleared of this particular legal difficulty, it will be recognized by the Corporation that the policy of a fair field and no favour between the rival suppliers of gas and electricity will most surely tend to secure the best service to the community as a whole. It is in this confident hope and belief that my Board have decided that although costs against the Corporation were awarded to my Company by the Court, no steps will be taken to enforce payment of the same."

Raw Material Costs

On more than one recent occasion we have discussed the possibility—rapidly becoming a probability—of the Gas Industry having to face up to an increased cost of its primary raw material, and we have suggested ways in which preparations should urgently be made to meet the situation. Point is given the question of urgency by a line of thought which is running in certain minds, and which was voiced, for example, by the Labour Correspondent of *The Times* in last Saturday's issue. In a discussion of the coal situation as it then stood, he made the following significant comment: "Because of the time required to establish the selling agencies and the further time required for the completion of contracts already made, many months must elapse—probably a year—before the collieries reap the benefit of the selling agencies. It is suggested that the large semi-monopoly undertakings, like gas and electricity concerns, might voluntarily release the collieries from the fulfilment of the long contracts that are now held; but the industry cannot rely on any such action. The proposal has not been made, much less considered; and it would probably require the backing of the Government."

The suggestions of "voluntary release" and "Government backing" in almost the same breath have a sinister sound, and it seems to us quite probable that our Industry, willing as it has declared itself to play any reasonable part in this national emergency, may not actually have much say, when the time comes, in the question of what is, and what is not, reasonable. At all events, we must be prepared for the possibility of quick developments and the necessity for rapid adjustments in spite of any contracts upon which we may have been relying for a tide-over period.

It would be just as well, while considering the probable increase in price in our coal supplies, not to lose sight of the trend of costs in other directions too. On the whole, as business men we must welcome the recovery which has taken place in raw material and commodity prices since the depths of the depression, though it is usually not quite so easy to rejoice over recovery which affects one's own particular raw material as it is over other people's good fortune in this respect. Be that as it may, the recent return of a Government which in the past has frequently given its blessing to such price recovery would seem to indicate the probability of a continuance, rather than a halt, in the movement. Whereas in 1931, when the National Government came into being, prices were weak and vulnerable, and little capable of withstanding the influence of sterling depreciation, there is evidence to-day of a much stronger tone in almost all markets. World trade is reviving, however slowly, and as the revival develops, recovery in world consumption, and hence in prices, would seem to be indicated.

Let us examine a few examples. The Gas Industry is a very considerable user of lead, and the price of ingot lead has increased between 1931 and the present time from about £12 to £20 a ton. On the utilization side some of the chief materials in demand are ingot tin, which has increased in the same period approximately from £110 to £225 a ton, and tin plates by £6 a ton to £36. Antimony plays its part, even if a smaller one, but its price has more than doubled from £30 to £74, while leather is approximately 15% up. Even in the past month pig iron prices are up by 4s. to 5s. a ton, and steel sheets by as much as 7s. 6d. In quite recent times, too, an additional cost for the Industry to bear has been a rise of 2s. a week in the wage of all adult workers by arrangement between the Engineering Federation and the Engineering Union, affecting, of course, a very wide range of the appliances through which gas is sold.

There are doubtless many other directions in which movements in commodity prices are coming home to us, and we quote these few examples not in any sense of alarm, but having in mind more and more the need for strengthening up our own commercial organization. In the forefront of measures to be taken we still place a more general revision of our methods of charge, and we shall hope for such a crop of attractive tariffs in the new year as will indicate a majority movement by the Industry away from the flat rate as the only inducement to the consumer to increase his demands.

Personal

We learn that Mr. J. Clifford Tozer was elected Chairman, and Mr. H. E. Wright Vice-Chairman, of the Gas Committee of the Plymouth City Council at a meeting on Nov. 28.

* * *

Brighouse Town Council has approved the appointment of Mr. John Corrigan, of Penrith, to be the new Gas Engineer and Manager, in succession to Mr. C. R. Ingham.

* * *

Mr. R. J. Milbourne, J.P., Assoc.M.Inst.C.E., has been appointed Chairman of the Wellington (Salop) Gas Company. Mr. Milbourne was previously Vice-Chairman of the Company.

* * *

Alderman Clark has again been elected Chairman of the Gas Committee of the Chesterfield Corporation. It is interesting to note that he has been Chairman of this Committee continuously for twenty-three years, having been elected twenty-four times in succession; in 1920 he was elected in May and again in November of that year.

* * *

Mr. W. B. McLusky took the Chair at the annual dinner of the Halifax St. Andrew's Society. The chief guest was the Duke of Atholl, the Society's patron.

North of England Auxiliary Association

Half-Yearly Meeting at Newcastle

The 31st Half-Yearly Meeting of the Auxiliary Section of the North of England Gas Managers' Association was held at the Gas Offices, Newcastle, on Saturday, Nov. 30.

Mr. S. W. A. Wikner (Manager of the St. Anthony's By-Product Works of the Newcastle and Gateshead Gas Company), the retiring Chairman, presided, and announced the election of the following officers for the ensuing year:

Chairman.—J. R. Porter (South Shields).
Vice-Chairman.—J. W. Pallister (Middlesbrough).
Elected to the Committee.—A. H. Bagshaw (Sunderland.
Hon. Secretary.—L. M. Weldon (West Hartlepool).

To mark his year of office, Mr. Wikner was presented with a presidential certificate by the Chairman-Elect.

A Paper was presented by Mr. D. Yule (of South Shields) on the subject of "Distribution and Service Operations," and this, together with a report of the discussion which followed, will be published in a subsequent issue of the "Journal."

News in Brief

Recent B.C.G.A. Publications include " Mr. Therm in Wonderland " and " The Use of Gas in Dairies," which is the latest addition to the series " A Thousand-and-One Uses for Gas."

A New 4-in. Main is to be laid by the Lanark County Council from the Gas-Works, East Kilbride, to Maxwellton, at a cost of £598. It is expected that this will give an ample supply to Maxwellton as well as shortening the distance from the gas main to the Kirkton housing scheme.

Application is Intended to be made to the Board of Trade for a Special Order under the Gas Undertakings Acts, 1920 to 1934, by the Narborough, Blaby, Enderby, and Whetstone Gas-Light and Coke Company, Ltd., with the object *inter alia* of extending the existing limits of supply.

Electricity Failed shortly after the opening of the Engineering Exhibition at the Greyfriars Hall, Cardiff, on Nov. 20. The exhibits of the British Road Tar Association and the Cardiff Gas Light and Coke Company, both lighted by gas, immediately became the centre of an admiring throng of visitors.

Interesting Figures are Available at Bolton, where 345 miles of thoroughfares out of a total of 360 miles are lighted by gas, the remaining 15 miles being covered by electricity. Over 7,750 gas lamps consume some 110 million cu.ft. per annum at an average price of 2s. 3d. per cu.ft. The public lighting rate is 7·1d. in the pound.

The Annual Cookery Competition for Schoolgirls arranged by York Gas Company was held recently and attracted 15 girls from 15 of the City's schools, as competitors, and a large gathering of citizens as spectators. The Gas Company gives a silver Cup to be held by the winning school and there are prizes for the most successful girls individually.

A Display is being staged by the Bradford Corporation Gas Department from Dec. 2 to 8 at a small but very attractive Trades Exhibition in the expansive lounge of the New Victoria Cinema, Bradford's biggest and latest picture theatre. The show is associated with a local newspaper competition and the display of the British film " The Thirty-Nine Steps."

Nine Gas-Fired Boilers with a total output rating of 1,500,000 B.Th.U. per hour are being installed in connection with improvements at the Tooting Baths of the Wandsworth Borough Council. The boilers are designed for direct hot water supply and are being installed to the instructions of the Wandsworth and District Gas Company by Thomas Potterton (Heating Engineers), Ltd.

A Smoke Abatement Exhibition was opened on Dec. 3 at 9, Victoria Buildings, Deansgate, Manchester, and will remain open for three weeks. The Public Health Department of the City has lent a number of exhibits showing the evil effects of smoke. The exhibition was arranged and organized by the Manchester, Salford, and District Branch of the National Smoke Abatement Society.

The Important Part played by the Gas Industry in bringing about a revolution in the home was emphasized by ex-Bailie A. Gowans, Convener of the Gas Committee of Perth Town Council, in opening of an exhibition at Scone. Bailie Gowans said there were seven million women in the country using gas cookers at the present time, and, to paraphrase the chorus of a popular song, " Seven Million Women can't be Wrong! "

The Net Cost of Lighting the streets of Salford by gas and electricity during the last financial year amounted to £41,207, which was a decrease of £2,279 on the previous year. The Street Lighting Department, of which Mr. H. S. Whitehead is Superintendent, has apportioned the amounts as follows: Gas lighting, £27,376; electric lighting, £13,831. There are approximately 182 miles of streets in the city lighted by gas, and thirty miles by electricity.

Compressed Coal Gas will be used instead of petrol for a six months' trial by 25% of the Halifax Corporation's commercial motor vehicles. This is the result of an agreement between the newly formed Heat, Light, and Power Committee and the Transport Committee. Mr. W. B. McLusky, the Gas Engineer and Manager, has been authorized to secure tenders for the equipment of the vehicles and the necessary storage and compressing plant.

Two Debates of particular interest to the Gas Industry will be held at forthcoming informal meetings of the Institute of Fuel. On Friday, Dec. 6, at British Industries House, Marble Arch, at 6.30 p.m., Mr. H. A. Humphrey will open a discussion on " The Adequacy of our Fuel Supplies in a Time of National Emergency," and on Friday, Jan. 17, at the same time and place, Messrs. H. L. Pirie and Isaac Lubbock will open a debate on the question " Has the Fuel Oil Tax Justified Itself? "

That Gas was being Increasingly Recognized as a real economic ally in all branches of industry was the view expressed by Mr. George P. Mitchell, General Manager of the Worcester New Gas Light Company, when addressing a large party of the Association of Engineering and Shipbuilding Draughtsmen on Nov. 30. The Association were visiting the Company's Works, following a successful lecture the previous week by Mr. H. R. Hems, the Chief Assistant in the Industrial Heating Section of the City of Birmingham Gas Department.

Record Attendances were registered at the fortnight's Gas Cookery Demonstrations, given in the Demonstration Hall at the Redditch Gas Company's Showrooms recently. Cake-baking and numerous other competitions were arranged which contributed to the success of the occasion. The demonstrations were conducted by Miss C. P. Hill, diplomèe, C.D.S., Y.T.C.H., the Company's Demonstrator, whose work is greatly appreciated by consumers. A Ladies' Gas Circle has been formed at Redditch and ninety new members were enrolled during the demonstrations.

Gas was Well to the Fore at the Northern Exhibition of Inventions held at Newcastle-upon-Tyne from Nov. 20 to 30. The Newcastle-upon-Tyne and Gateshead Gas Company selected for display at their stand all the latest " inventions " in gas equipment, including distance lighting and gas fire switches, thermostatic control of ovens and water heaters, cooling units of gas refrigerators, " Calor " gas equipment, and self-lighting fires, &c. The display arrested very considerable attention by the thousands visiting the exhibition daily, and also received good press publicity.

Compression Plant has been installed at the Arbroath Gas-Works, and by means of the apparatus it is anticipated that possible complaints of insufficient pressure in the supply in certain areas of the town will be obviated. For some time past two gasholders had been out of commission as they had proved ineffective in so far as they had not provided the necessary pressure to the areas in the town they served. The gasholders had, therefore, been used merely as storage vessels, but they have now been linked with the new compression plant, which is complete with governors, and the defects have thereby been removed. The new unit has been installed by Messrs. Keith & Blackman Co., Ltd.

The Institution of Gas Engineers

Members of The Institution of Gas Engineers are invited to attend the Inaugural Meeting of the 55th Session of the Junior Institution of Engineers on Friday, Dec. 13, 1935, at 7.30 p.m., at the Royal Society of Arts, John Street, Adelphi, W.C. 1, when Sir Frank E. Smith, K.C.B., C.B.E., D.Sc., LL.D., Sec.R.S., will be inducted President of the Institution, and will deliver his Address " Coal, Power, and Smoke."

The Chair will be taken by the retiring President, Clifford Copland Paterson, O.B.E., M.Inst.C.E., M.I.E.E., F.Inst.P. Refreshments will be served after the meeting.

Tickets of admission may be obtained from the Secretary of The Institution of Gas Engineers, 28, Grosvenor Gardens, S.W. 1.

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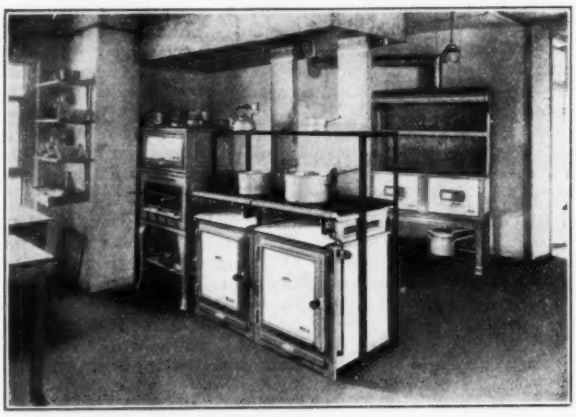
Page 10. BRIGHOUSE. J. Corrigan appointed E. & M.
Page 52. PENRITH J. Corrigan resigned.
Page 92. STIRLING. J. Bell resigned.

Amalgamation and Grouping

Belfast and Holywood.

The Belfast Gas Committee at a special meeting on Nov. 27 agreed to purchase the Holywood Gas Undertaking at a sum of £27,000. The Engineer, Manager, and Secretary of the Belfast Gas Department, Mr. J. D. Smith, M.Inst.C.E., reported on negotiations with representatives of the Holywood Gas Company, and said it had been agreed that, subject to the approval of the Council, the complete Undertaking should become the property of the Corporation, at a date to be mutually agreed upon, for £27,000, this figure to include everything with the exception of the stock of coal at the date of taking over, which would be an extra at current value. Mr. Smith recommended the purchase on the terms stated, and the Committee adopted his recommendation, subject to all necessary approvals, including the obtaining of a loan to finance the purchase and incidental expenditure. The sale of the Undertaking is subject to ratification by the shareholders of the Company. The Corporation's Finance Committee later approved of the purchase. Holywood is a town of nearly 6,000 inhabitants about four miles from Belfast. It is expected that it will be embraced in an extension of the City boundary in the near future.

Modern Hotel Equipment



A recent installation of Parkinson modern hotel gas cooking equipment in the new Victoria Hotel, Birmingham. In the foreground are seen two "Unita" hotel cookers, on the left of the photograph is the Company's hotel griller on stand, while in the rear is the Parkinson fish fryer.

The Women's Gas Council

A meeting of the Women's Gas Council was held on Dec. 2 at 16, Bruton Street, W. 1, when the guests were received by the Dowager Lady Nunburnholme, J.P. The principal speaker on this occasion was Lady Doris Blacker.

The chair was taken by Sir David Milne-Watson, D.L., LL.D., who said that a letter had been received from the Marchioness of Londonderry expressing regret at being unable to attend. Lady Doris Blacker confined her remarks chiefly to food and home decoration. The Chairman of the W.G.C., Miss Wolseley-Lewis, then pointed to the reasons for the existence of the Council which owed its inception to the fact that previously there had existed no platform on which women consumers could voice their views. There had lately been held an international conference concerned with scientific management in domestic affairs and at a meeting of the British Association at Norwich for the first time a domestic Paper had been read. These she thought were signs that there was a field for detailed investigation and dissemination of information about the better conduct of home affairs. The Gas Industry's contribution towards this movement had been the establishment of a council of consumers thus linking the housewife and the consumer in such a way as was previously impossible.

The Organizing Secretary, Miss Kathleen M. Halpin, indicated that the Council was a national body, and was, therefore, entitled to affiliation with kindred institutions which aimed at removing the drudgery and soul-destroying tasks which sapped the energies of the housewife. She went on to give examples of the work that was being done by branches up and down the country and concluded by observing that their Council could truly be said to have taken its stand among those who were performing a very definite service to the community in attempting to raise the standard of home life.

The meeting ended after the showing of two of the new B.C.G.A. Publicity Films, "The Romance of a Lump of Coal" and "The Dinner Hour."

The Gas Films

By the courtesy of the B.C.G.A. we were privileged to be an observer of a display of the gas films last week to an "existing" audience. By invitation of the Gas Light and Coke Company, well over 300 members, with wives and families, of the Central Finsbury Club in a typical working-class district of London attended the show. A Western Electric portable talking picture apparatus showed the films, which were interspersed as "interest" reels in a varied programme of cartoon, Nature, and comic material.

The interest of the audience in the gas films was quite evident, and each at its conclusion was awarded a round of applause which showed that it had quite definitely held the attention of the mixed gathering of both sexes and all ages. We understand that the films are now being shown by gas undertakings over a wide area from Newcastle to Liverpool, and from London to the South-West of the country, and that those who are providing them as entertainment are very gratified with their reception.

Forthcoming Engagements

Dec.

5.—Midland Junior Association.—Annual Dinner.
7.—Scottish Eastern Junior Association.—Meeting at Arbroath.
10.—Federation of Gas Employers.—Central Committee at 12 noon.
10.—N.G.C.—Meeting of Central Executive Board at 2.30 p.m.
11.—B.G.F.—1st Annual General Meeting, Grosvenor House, Park Lane, London, W. 1, 3 p.m.; 2nd Annual Dinner, Grosvenor House, Park Lane, London, W. 1, 7 p.m.
11.—S.B.G.I.—Council Meeting, 11.15 a.m.
11.—I.G.E.—Finance Committee, 9.30 a.m.; Membership Committee, 9.30 a.m.; General Purposes Committee, 9.30 a.m.; and Council, 11 a.m.
13.—London and Southern Junior Association.—Paper by Mr. L. Friedman, of Ascot Gas Water Heaters, Ltd.
14.—Scottish Western Junior Association.—Meeting and Address by Mr. W. D. Rowe, of the B.C.G.A.
14.—Wales and Monmouthshire Junior Association.—Meeting at Cardiff. Paper by Mr. B. J. Bell.
14.—Western Junior Association.—Meeting at Torquay. Paper by Mr. J. W. Denton, of Torquay.
21.—Scottish Western Junior Association.—Annual Social.

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Jan.

11.—Scottish Junior Association.—Joint Meeting in Glasgow. Address by Mr. H. C. Smith.
16.—Midland Junior Association.—Meeting. Paper by Mr. B. Green.
18.—Western Junior Association.—Meeting at Bath. Paper by Mr. F. G. O'Neill.
18.—Yorkshire Junior Association.—Meeting at Oldham. Paper by Mr. R. E. Stott.
24.—London and Southern Junior Association.—Meeting. Paper by Mr. T. A. Wolfe.
25.—Wales and Monmouthshire Junior Association.—Meeting. Paper by Mr. C. F. Petersen.

Feb.

6.—Midland Junior Association.—Meeting. Paper by Mr. G. C. Pearson.
8.—Manchester and District Junior Association.—Meeting at Darwen. Paper by Mr. J. A. Derbyshire.
8.—Scottish Western Junior Association.—Meeting.
14.—London and Southern Junior Association.—Meeting. Paper by Dr. F. J. Dent.
15.—Scottish Western Junior Association.—Annual Social.
15.—Scottish Eastern Junior Association.—Meeting at Perth.
15.—Yorkshire Junior Association.—Short Paper Meeting at Bradford.

British Road Tar Association

Luncheon at Cardiff

Over 160 members and guests attended the B.R.T.A. annual luncheon at the Park Hotel, Cardiff on Nov. 28, 1935, under the Chairmanship of Mr. H. D. Madden, M.Inst.C.E., Engineer and Manager of Cardiff Gas Light and Coke Company.

The loyal toast having been honoured, Mr. E. J. Fottrell, B.Sc., A.M.Inst.C.E., proposed "Prosperity to the Trade of South Wales." In the course of his remarks Mr. Fottrell said that he appreciated the honour done to him when he was asked to propose this important toast. In the present wave of economic nationalism and industrial depression, South Wales had been the hardest hit area in the British Isles. But South Wales did not give in; it set out to introduce new industries and to consolidate the position of existing ones. Even at the present time signs of a trade revival were in sight. Coal exports were improving, and the great Guest, Keen, Baldwin Company were shortly to open their new £2,000,000 Works at East Moors, Cardiff. This venture was one of the most ambitious ever carried out and when working they would carbonize 1,000 tons of coal per diem. A word of congratulation was also due to the Cardiff Corporation Development Committee for their help in this revitalization of industry, and only that day he had heard that a large American firm was considering moving their works over to South Wales. The Lord Mayor of Cardiff, Alderman G. Fred Evans, in his reply thanked Mr. Fottrell for his kind remarks.

Alderman Sir Charles Bird, C.B.E., J.P., proposed "Other Guests," and Mr. H. H. Merrett, President of the Cardiff Chamber of Commerce, replied.

"The British Road Tar Association" was proposed by Mr. W. J. Hadfield, C.B.E., M.Inst.C.E. (City Engineer, Sheffield). In response, Mr. R. G. Clarry, M.P., thanked Mr. Hadfield and said that even miners themselves did not seem to realize the importance of the derivatives from coal. He would like to state in connection with the stabilizing of pitch prices, that the B.R.T.A. was a non-trading body and as such had no control over tar or pitch prices.

Visit to the Engineering Exhibition.

Following the luncheon the members visited the Engineering Exhibition at the Greyfriars Hall and were welcomed by Mr. David Roberts (Vice-Chairman of the Exhibition Committee). Mr. H. Matterface (President of the Wales and Monmouthshire Association of Gas Engineers) thanked Mr. Roberts and said that he was sure that all the members would benefit from the visit.

"British Tar for British Roads," the slogan of the B.R.T.A., was emphasized by an attractive display arranged by the South Wales District Branch, comprising an interesting working exhibit of a coke oven plant showing the various phases of tar extraction from coal, and a number of photographs of tar-treated roads, demonstrating to the public the suitability of home-produced tar for use on all kinds of roads.

The exhibit of the Cardiff Gas Light and Coke Company was designed and erected under the direction of Mr. H. D. Madden, and made a very fine impression on all who visited it. It was situated near to the main entrance, and, at a height of about 12 ft. from the floor and immediately inside the entrance doors was fixed a "Cox" radiant heating unit, cheery warmth from this, striking down on the heads of the visitors, at once drew their attention to the merits of gas for heating. The staff of the Industrial Research Laboratory were on duty, ready to answer any enquiries about the use of gas for industrial processes. Apparatus displayed included industrial gas burners and injectors, steam-raising plant, central heating, heat treatment of metals, drying and baking plants, together with furnaces and equipment to demonstrate the use of gas in the laboratory. The stand was finished in red and buff, and was adorned with plaques illustrating the various trades in which gas is used industrially, and upon either side was a list of the seventeen members of the Industrial Centre at Cardiff.

Party Dainties for the Young Folk

A New Radiation Publication

An attractive and well produced little booklet has been published by Radiation Ltd. under the above title for the Christmas season. Copies are being distributed free to gas undertakings in the hope that they will be acceptable to gas consumers for the festive season.

The tea or supper table is the first consideration, and the original suggestions for spectacular displays given in the booklet will make a ready appeal to the young folk. Excellent full-page illustrations show how the various "set pieces" may be arranged quickly and daintily.

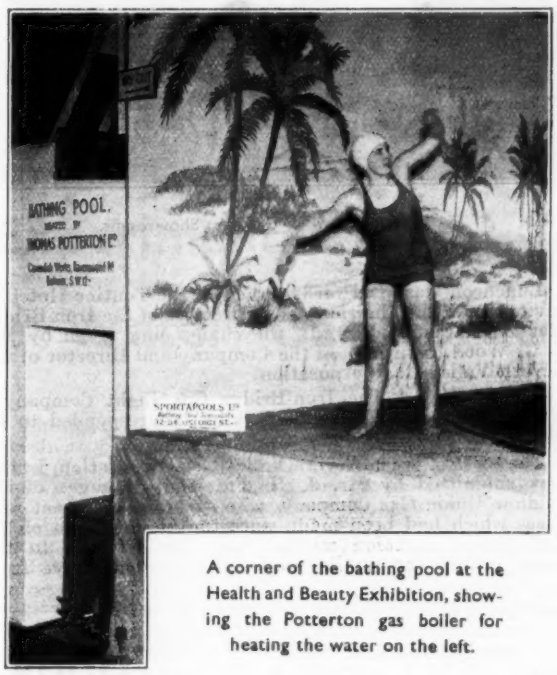
A large number of useful recipes for the Christmas party are included, together with the "Regulo" settings for use with the "New World" cooker, each recipe having been carefully tested in the Radiation Research Kitchen, two photographs of which show the modern apparatus for extensive research and experiment with which it is equipped.

Gas for Health and Beauty

Interesting Displays at Exhibition

The Health and Beauty Exhibition was opened last Friday at the new Horticultural Hall, Westminster, and, being the first of its kind, it attracted a considerable amount of public interest.

The part which gas could play at an exhibition of this nature might at first sight seem small, but the Gas Light and Coke Company, always ready to seize every opportunity of putting the merits of gas for all purposes before the public eye, set up an extremely attractive display, centred round the idea that gas constitutes the cheapest and healthiest, as well as the most efficient, method of providing all the essential domestic services.



A corner of the bathing pool at the Health and Beauty Exhibition, showing the Potterton gas boiler for heating the water on the left.

A range of gas water heating appliances, in pleasing enamelled finishes, formed a striking centrepiece, supported by an ingenious impression of a figure standing enveloped in steam beside a hot bath. Concealed lighting threw the whole into effective relief. Arranged around the stand were further domestic appliances, including a refrigerator, enamelled cookers, a "Portcullis" fire, a radiant bowl heater for health treatment, a portable gas fire, and the G.L.C. milk boiler in stainless steel finish. An enquiry counter with a display of relevant literature thereon completed a very striking exhibit.

A Gas-Heated Swimming Pool.

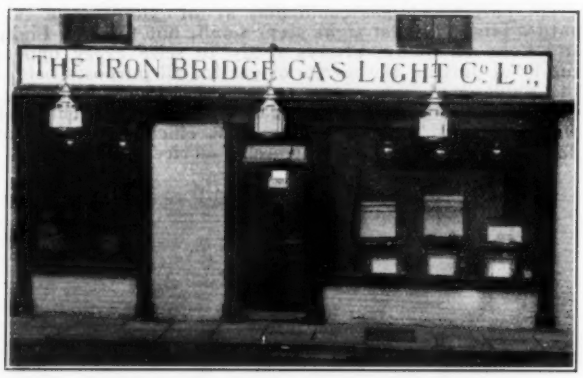
One of the features of the exhibition was the swimming pool, in connection with which displays of diving were staged. Here again gas played an important part, for diving at this time of the year into cold water cannot be regarded as an attractive proposition.

The 5,000-gallon canvas pool had, therefore, to be provided with some form of water heating equipment, and this consisted of a "Rex" gas-fired boiler by Thomas Potterton, Ltd. The heater itself was classed as an exhibit, and, indeed, with pleasing mottled enamelled finish, chromium-plated fittings, was a very interesting one. The boiler had an output of 132,000 B.Th.U. per hour, working under thermostatic control on the gravity principle, and maintained the water temperature at about 70° F.—thus giving comfortable conditions for bathing. It may be mentioned that the boiler was quite free from condensation.

New Showrooms at Iron-Bridge Opened by the Mayor

New showrooms were opened for the Iron-Bridge Gas Light Company on Nov. 26 by the Mayor of Wenlock, who was supported by the Mayoress and a representative gathering.

Following an inspection of the new premises the company adjourned to the Parish Room where demonstrations were given during the week under the auspices of the Iron-Bridge Gas Company, the Dawley Gas Company, and the Broseley Gas and Coke Company. Demonstrations in cookery were given by Miss R. M. Thring, N.C.D.S., and Miss Taylor, and the washing machine demonstrations were given by Miss K. Bancroft, of Messrs. W. H. Dean & Son, Ltd. A cake-baking competition was also organized.



Exterior View of the new Showrooms.

Luncheon was afterwards served at the Tontine Hotel by invitation of the Chairman and Directors of the Iron-Bridge Gas Light Company, Ltd., the chair being taken by Mr. S. G. Wood, Chairman of the Company and Director of the Severn Valley Gas Corporation.

The toast of "The Iron-Bridge Gas Light Company" was proposed by Alderman Nicklin and responded to by Mr. G. M. Gill.

The toast of "The Severn Valley Gas Corporation, Ltd.," was submitted by Mr. J. H. Paterson, Manager of the Ludlow Union Gas Company, who spoke of the great progress which had been made since the inauguration of the Corporation eighteen months ago. He referred to the great benefit the smaller undertakings would have from the experience of the financial and technical experts of the larger body. In responding, Mr. S. G. Wood said that the Corporation had already justified its existence and now controlled some seventeen undertakings.

Fuel Luncheon Club

The inaugural luncheon in connection with the proposed Fuel Luncheon Club, reference to which was made in the "JOURNAL" for Nov. 20, was held at the Connaught Rooms, London, on Wednesday last, when Sir John Cadman, first President of the Club, explained its aims. The Club, he said, will have achieved its principal aim if, merely by its sociability, it encourages greater and more frequent contact between the technical men of the different branches of our fuel industries. Those contacts, once established, may widen until they embrace all branches and knit them, maybe into a structural unity, or at least into a network of co-ordinated organizations.

At the present time, he continued, there is too little contact among our fuel industries. Each keeps to itself, pursues its own aims, benefits from its own discoveries, and tends to ignore the advances of others. No section regards itself as part of an organization having a single aim; nor does any section co-operate with others for the benefit of all. The coal industry, for instance—in itself a complicated entity—produces and sells a raw material in the form of lumps of coal. Once the coal is sold, the industry cares little what happens to that fuel. It makes no attempt to extend its operations and to approach more closely to the ultimate consumer of heat. Yet, throughout our fuel industries there is mutual dependence. One industry depends upon another for the purchase of its products. That other relies upon a third for a convenient material to increase calorific content. A fourth depends upon the operations of all others for sales. That commercial interdependence ought to have some parallel in our other activities. We ought not to be fierce competitors, self seeking, or regardless of the welfare of other sections of the fuel industries. Far from it! We serve a common purpose and we ought to have common aims. One of those aims should be to extract all that may be extracted economically from our raw material, whatever it may be. Another should be to supply manufacturers and the public with the best fuels we can produce, at reasonable prices. It may be argued that those are already our aims; and that each of us is doing what he can at attain them. To some extent that is true, but isolated efforts have not the force of concerted endeavour, nor have they the same purposeful direction. If we wish, effectually and rapidly, to achieve such aims, each of us must co-operate with all others who have any contribution to make. If we are to do that, we must begin somewhere. I can think of no better way of beginning than by the frequent contact among technical men which meetings of the Fuel Luncheon Club will provide.

Book Review

Fuel—Solid, Liquid, and Gaseous*

Many of the present generation of fuel technologists gained from Brame's "Fuel" their first knowledge of the subject to which they are devoting their lives. They will have at least a sentimental interest in the fact that the book is now celebrating its majority. This happy event is marked by the publication of a Fourth Edition in the preparation of which Prof. Brame has had the benefit of collaboration with Dr. J. G. King, whose name now appears as that of joint author. The book in its new form seems destined to prove as useful to the rising generation of fuel technologists as was the first edition to former students.

Brame built his book on a solid foundation of facts which are just as true now as they were twenty-one years ago; hence much of the descriptive matter has been retained in succeeding editions. The structure resting on this foundation has been modified from time to time with the result that the book has always been brought fully up to date when a new edition has been prepared. The choice of subject-matter, embracing as it does solid, liquid, and gaseous fuels, is so wide that it has been possible to select those features which are capable of presentation in an interesting manner. Indeed, the pleasant style in which the subject is handled has been one of the outstanding characteristics of the book. A further feature is the fact that much of the information is of a nature not usually found in a general treatise on fuels, and this renders the book a useful adjunct even to libraries which contain many of the other standard works on the subject.

It is unnecessary to refer at length to the contents of a book which has been before the public for so long a period and it will suffice if mention be made of a few of the new items of information which are to be found in the latest edition. Among the subjects treated in great detail in the light of the most recent investigations are the constitution of coal, the reactivity of coke, low-temperature carbonization, hydrogenation, the octane rating of motor fuels, the special characteristics of fuels for compression-ignition engines, the production of water gas and producer gas, the analysis and testing of fuels, and the use of the large variety of combustion recorders which are now available. As was only to be expected, the valuable reports of the Fuel Research Station have provided the source of much of the new information.

When "Fuel" first appeared, the attack of investigators on the constitution of coal was just gathering impetus. Much progress has been made in the interval but much

* "Fuel: Solid, Liquid, and Gaseous," by J. S. S. Brame and J. G. King. Fourth Edition. [London, 1935, Edward Arnold & Co.; pp. xvi. + 422. Price, 25s. net.]

remains to be discovered. On the other hand, it seems that nearly as much knowledge on the subject of the use of alcohol as motor fuel was available in pre-war days as is the case now. In a number of instances, a comparison of the fourth and first editions will provide much food for thought. To quote an example, the statement "the choice of fuel of a certain suitable kind should be governed largely by the heat units available per unit of cost, a matter that is slowly receiving the attention which its importance merits" appears in both editions. The choice of the word "slowly" was evidently a very happy one.

Careful study of the contents of the new edition leads to the view that by far the major portion of the information is accurate. In the case of the remainder of the material there are to be found a number of mistakes some of which have been carried through from the first edition to the latest. One might hold the view that Prof. Brame has been treated somewhat unfairly by his readers in that they have not shown him their gratitude for so excellent a treatise by pointing out some of the more readily noticeable mistakes. On their behalf some amends will now be made by reference to a few errors:

Page 27.—A cord of wood is given as 400 lb.

Page 66.—Parr's formula for unit volatile matter has been confused beyond recognition.

Page 126.—The weight of coke used in the shatter test is stated to be 5 lb.

Page 212.—"Although not strictly proportional to the density, the specific heat may be calculated from K/sp.gr., K being 0·35." Obviously, inversely proportional is meant.

Page 223.—"The British Air Ministry will be found on page 224."

Page 260.—According to a table of comparative statistics, it would appear that the gas-works of the United Kingdom carbonized 1·4 million tons less coal in 1933 than in 1931. Actually, however, the 1931 figure includes about 700,000 tons carbonized in non-statutory works, and a true comparison should show a difference of only 700,000 tons.

Page 262.—It is stated that there is a legal limit of 20 grains of organic S per 100 cu.ft. of purified town gas. In fact, there is now no limit, even though a much smaller limit than is mentioned might be desirable.

Page 279.—The expression for the water gas equilibrium is given as $CO + H_2O/CO_2 + H_2$ (*i.e.*, + signs instead of × signs).

Page 308.—"The wonderful development in the use of these poorer gaseous fuels . . . formed a marked feature in industrial progress at the end of the *twentieth* century."

The information on modern coke-oven technique is somewhat inaccurate. Here, the authors are dealing with matters outside their personal experience and, for future editions, they would do well to seek guidance from recognized authorities.

In conclusion, it may be urged that the authors should not banish the book from their thoughts until the time draws near for the publication of a further new edition. We would invite them, in the interval, to read and check every statement, literature reference, and figure. The task of tracking down a relatively small number of inaccuracies in some 400 pages of text is no matter to be hurriedly undertaken, but the undoubted value of the book would be still further enhanced if these mistakes could be eliminated in the next edition.

Fuel Research Station Experiments on the Water Gas Process

A Summary of Fuel Research Technical Paper No. 43. Published by H.M. Stationery Office, 1s. net.

"Further Experiments upon the Water-Gas Process" is the title of a Fuel Research Technical Paper just issued by the Department of Scientific and Industrial Research. Previous reports (Technical Papers Nos. 27 and 30) have described methods for the measurement of rapidly fluctuating flows of gas and for the preparation of carbon and thermal balances in connection with the water-gas process, and the present Report deals with the application of these methods to the study of important variables in the process.

In beginning this investigation it was realized that the accumulation of masses of clinker in the generator, though an extraneous factor in relation to the actual water-gas process, could nevertheless so influence the efficiency of the plant as to mask the effects of altering any of the true variables. The first part of the work covered by this Report was therefore directed to finding conditions under which the generator could be worked with entire avoidance of clinker formation. This end was successfully achieved by simple modifications of the plant and the method of operation. These modifications resulted in a reduction of about 50% in the output, and, though this was offset to some extent by an increased thermal efficiency of 20%, they would seldom be adopted in industry. In overcoming the masking effect just referred to, however, the expedient was in the present instance justifiable.

The variable effects of clinker formation having been eliminated, attention was turned to examining the effects of certain true variables—viz., the rate of blowing, the size of the coke, and the nature of the coke. Each of these was varied independently of the others, and its effect was assessed by carrying out trial runs for which full data were recorded and thermal and carbon balances prepared.

Experiments on the first of these—the rate of blowing—showed that for the greatest thermal efficiency during the blowing period the rate of blowing should be as high as practical limitations allow, which is normally that at which pieces of coke would be projected from the generator. To ensure that the temperature of the coke bed at the end of the blowing period did not exceed the optimum, however, the time of blowing was correspondingly decreased. In this way the percentage of carbon monoxide in the blow gas was reduced to a minimum and other thermal losses were also reduced.

Alteration of the size of the coke fed to the generator was shown to have only a slight effect upon the thermal efficiency of the process and the output of the plant, provided that the conditions of operation—in particular the time and rate of blowing—remained unchanged. Owing to the greater surface area of small coke, however, a decrease in size resulted in a lowering of the working temperature, and if the volume of air per blow period were increased to bring the temperature up to the normal level for larger coke the output of water gas could be greatly increased. This increased output, unless the rate of blowing could be made high enough (still avoiding projection of coke from the generator), must be at the expense of the thermal efficiency, but in cases where coke breeze is cheap the increase of output may outweigh the loss of efficiency.

The effect of the nature of the coke was investigated by using three cokes produced from the same coal under different carbonizing conditions. The first, representing the standard type of low-reactivity coke used in the water-gas process, was a horizontal gas retort coke; the second was produced at a somewhat lower temperature in vertical gas retorts; and the third was a low-temperature coke of high reactivity. It was evident that the heat treatment to which the coke was subjected in the upper part of the generator would tend to level out any differences that may have existed between the original cokes, and the results show that in the water-gas reactions the vertical and horizontal gas retort cokes behaved in a very similar manner. The low-temperature coke, however, showed appreciable differences due to its greater reactivity to carbon dioxide during the blow period and its higher content of volatile matter. The effect of the first cannot be overcome wholly by increasing the rate of blowing, owing to the low bulk density of the coke. The second contributes about 9 therms or 2,500 cu.ft. of gas per ton of dry ash-free coke to the yield, but is also responsible for a considerable loss in the blow-period.

An Appendix deals with the possible effect upon the accuracy of the thermal balance of certain minor factors—viz., the sulphur, hydrogen, and nitrogen in the coke, the moisture in the air, the dilution of the water-gas with blow-gas, as well as the dilution of the blow-gas with water-gas.

AUTUMN RESEARCH MEETING

Nov. 5 & 6, 1935

OF THE INSTITUTION

WRITTEN CONTRIBUTIONS AND REPLIES TO THE DISCUSSIONS

Communication No. 121—36th Report of the Joint Research Committee of the Institution and Leeds University. Corrosion from Products of Combustion of Gas—Part III. Tube Experiments.

Dr. U. R. EVANS (Cambridge University) wrote: The 36th Report of the Joint Research Committee contains matter of great practical importance, the accuracy of which is unlikely to be challenged. The discussion of the results also appears acceptable. Comparatively little has been said of the causes behind the action of sulphur, and on this matter some tentative suggestions may perhaps be added.

Most chemists would attribute the results to the corrosive character of sulphurous and sulphuric acids. Undeniably they would be right, but it is likely that sulphuric acid also plays a rôle in absorbing moisture and thus promoting wet conditions, where otherwise the metal would remain relatively dry. This action is very important in corrosion at room temperatures; how important it is in the corrosion produced by the products rising from a gas flame may be left to the writers of the Report to decide.

The *Principle of Critical Humidity* developed in recent years by Vernon,* Hudson,† and Patterson‡ states that below a certain humidity there is little atmospheric corrosion, but above this value, which represents the humidity at which the corrosion products can commence to absorb moisture from the atmosphere, the corrosion velocity increases rapidly. The same principle, suitably modified, will presumably be applicable to higher temperatures. Some examples of the effect of hygroscopic corrosion products may be cited from early work in the Cambridge Laboratory.§ Specimens of zinc exposed *over* (but not touching) concentrated hydrochloric acid became visibly wet and rapidly corroded, although the humidity of the atmosphere was much less than 100 per cent.; this was due to the hygroscopic character of zinc chloride. Similarly, copper exposed over concentrated ammonia became covered with drops of deep violet liquid containing a complex nitrite; in forming this hygroscopic compound, oxidation of ammonia to nitrous acid, catalytically stimulated by the copper surface, played an important part. When nickel was exposed over concentrated sulphurous acid it also became wet and rapidly corroded; other metals such as lead, tin, and copper, which failed to absorb water under the conditions in question, remained very little attacked. In the case of nickel, the hygroscopic body can hardly have been a sulphate or sulphite of nickel; the absorption of moisture must be ascribed to sulphuric acid produced by the oxidation of sulphurous acid through the catalytic activity of the nickel.

It would appear to me quite probable that the power of sulphuric acid to collect moisture readily at places where the temperature is well above the ordinary dew-point, may have been an important influence in the stimulation of corrosion by the combustion products of coal-gas containing sulphur; if this is the case, the catalytic power of certain metals, such as nickel (and possibly, under some conditions, copper), to stimulate the oxidation of sulphurous acid to sulphuric, is certain to affect the rate of attack.

Professor J. W. COBB (Livesey Professor) wrote: My introduction of the Report was directed in part towards explaining how intricate is the subject of the attack of products of combustion on metals, and how carefully on that account experimental work has to be planned and carried out in proper sequence if useful results are to be obtained. The attack at high temperatures is quite different, not only in degree, but in kind, from that at low temperatures, where extensive condensation of steam is occurring. It is this latter condition which gives rise to what may be called corrosion proper. It occurs in a number of appliances and lends itself to precise experimental investigation and the obtaining of comparative results, which can often be directly applied with confidence. The behaviour of products of combustion in gas appliances is, however, not always of this kind. There may be no condensation and, as Mr. Masterman points out, quite rightly and usefully, there may be condensation followed by a re-evaporation and consequent accumulation of obstructive solid deposits. The necessity for investigating this kind of condensation-*plus*-evaporation corrosion, is plainly very much to the front in Mr. Masterman's mind, and his conviction is derived from a wide experience of practice. It is one which I think will be generally shared. At the same time, I submit that there was very good reason for examining corrosion with condensation, since it is not only important in itself, but is the first stage in the more complicated two-stage process of condensation followed by evaporation, and there is no sounder rule in scientific investigation than that of examining the first stage in a two-stage process separately when, as in this case, that can be done.

I take this opportunity of thanking Dr. Hartley for his kind offer to assist us by the X-ray examination of the corrosion films, particularly of tin, an offer of which we hope to avail ourselves.

Mr. James W. Wood's Written Reply.

Mr. JAMES W. WOOD (Research Chemist), in reply, wrote: The corrosion results of the 36th Report, obtained under fully condensing conditions, are criticized because they do not furnish a *direct* measure of the effects of sulphur variation upon corrosion in actual gas appliances—a criticism which is, of course, justified.

On the other hand, while complete condensation of the water produced by the combustion of gas is exceptional in modern gas appliances, there are many in which partial condensation takes place, and the data of the 36th Report will furnish a useful guide in these cases if applied with discretion.

The conditions of testing were definite and reproducible, and represent one end of a series of conditions, the other being high temperature dry scaling, but there are quite a number of intermediate stages of partial condensation, with or without re-evaporation. Professor Cobb has given above good reasons for regarding tests under fully condensing conditions as essential to the proper understanding of practical corrosion problems in which partial condensation followed by re-evaporation is involved.

Both Mr. Masterman and Dr. Hartley point out that full condensation may wash away corrosion products and so prevent accumulations in flue-ways such as sometimes occur with partial condensation, and cause indifferent combustion. The relatively large volume of corrosion product for a light metal like aluminium is specifically mentioned, but as was pointed out in the 33rd Report of the Joint Research Committee, partial or intermittent condensation can give rise to voluminous deposits even with metals of normal density, such as copper and nickel.

The conclusions given in the Report with regard to gases of very low sulphur content are only tentative. The latest results are in accord with those submitted by Mr. C. A. Masterman, the corrosion differences being in quantity rather than in kind, and probably explainable by the differences in the experimental conditions in the two investigations.

The additional reasons put forward by Mr. Masterman and Dr. Hartley for reducing the sulphur content of town gas, apart from the question of corrosion, will be generally admitted. Variation in composition of gas and in the conditions of combustion may very well give rise to a variable production of nitric oxide, and a variation in its rate of conversion to nitrogen acids, both of which will assume greater importance as the sulphur content of the gas is reduced.

Thanks are due to Dr. U. R. Evans for his continued

* W. H. J. Vernon, Trans. Faraday Soc., 1927, **23**, 162 (footnote); 1931, **27**, 264.

† J. C. Hudson, Trans. Faraday Soc., 1929, **25**, 205.

‡ W. S. Patterson and L. Hebbs, Trans. Faraday Soc., 1931, **27**, 277.

§ U. R. Evans, Trans. Faraday Soc., 1923, **19**, 201.

interest in this work and for his written contribution to the discussion. In the Report tests the condensation of the water produced by the combustion of the gas was so copious that the question of a critical humidity did not arise. With partial condensation, however, it could be very important, and would be influenced in the manner suggested by Dr. Evans by variations in the amount of sulphur in the gas, and in the ratio of sulphurous to sulphuric acid in the products of combustion.

In nearly all the experiments of the 36th Report the sulphur in the condensates was in the form of sulphuric acid or metallic sulphates. The question of the form in which the sulphur exists in the flue gases themselves is, however, still a matter of doubt. The question receives further attention in the Report on Air Vitiation and Gas Appliances by C. A. Maserman, E. W. B. Dunning, and A. B. Densham, Communication No. 116, where possible methods of determining the SO_2/SO_3 ratio are discussed.

Communication No. 122 – 37th Report of the Joint Research Committee of the Institution and Leeds University. The Controlled Operation of a Carburetted Water Gas Plant—Part II.

Mr. R. V. THOMAS (Fuel Research Station) wrote: Although the 37th Report of the Joint Research Committee is an admirable analysis of the results of the experiments already described in the 35th Report, from the point of view, as Dr. Dent makes clear, of the practical gas engineer, I personally would have liked to see them presented if possible in a somewhat more detached way.

For example, in the experiments on the effect of varying air/steam ratio the other variables remain unchanged, and consequently with increased rate of steaming the average working temperature of the reaction zone falls. In the next set of experiments the time of blowing is altered, the rate of steaming being adjusted so as to give a blue gas of constant quality; under these conditions increased time of blow means increased working temperature. Now since, as Dr. Dent himself points out, the average working temperature is one of the basic factors of the blue gas process, it would have been of great theoretical interest—and therefore, indirectly, of *practical* value—to have an analysis of the effects of altering the variables under "iso-thermal" conditions. It is true that in Figures 14 and 15 we find the two sets of experiments so correlated as to show the variations occurring when the generator is self-supporting in steam. This, Dr. Dent says, means that the average temperature "must remain approximately steady." A comparison of the curve with Dr. Dent's argument shows, however, that it *is* only approximate.

Admittedly, direct determination of the temperature of the reaction zone would be difficult or impossible in a generator of this type, as Dr. Dent himself implies. Nevertheless it would have been of interest to attempt a more direct approach to isothermal conditions by correlating the results of Tests Series I. and II. on the basis also of constant heat of blow-gas per unit volume, or even, more simply, of constant CO content.

In this connection it would be interesting to consider whether the hourly evaporation from the annular boiler might not afford a good measure of the working temperature. Has Dr. Dent investigated this question? Inspection of the tables shows that the evaporation increases markedly in every series with rising fuel-bed temperature, except in Table 14, when it falls slightly. What explanation can Dr. Dent offer for this anomaly? If the evaporation can be correlated with certainty with the temperature, it might be a very useful datum, particularly in the more general instance when the CO content of the blow-gas is not a measure of the temperature.

With regard to the calculation of the results, it is to be noted that Dr. Dent, following Travers, seems to make no use of the volume of air per blow, but, in effect, the volume of blow-gas is calculated from a theoretical, perfect, heat balance. In fact it seems rather strange that nowhere is an experimental thermal balance given, and only in Table 19 a carbon balance. Furthermore, it is remarked in the 35th Report that throughout the tables actual experimental values are not quoted, but only "smoothed" ones. With a hand operated plant it has proved difficult to attain the uniformity of working desired for experimental work, and it would have been of particular interest to me to see how far these difficulties can be overcome with an automatic plant of this type.

Mr. LEON J. WILLIEN (Chicago) wrote: According to the Report, 20 in. W.G. blast pressure seems to be the normal pressure used in England. In America a much higher blast pressure is used. It varies from 36 to 42 in.

The following statement appears in the course of the Report: "With rapid rates of steam supply a higher rate of gas production, more complete decomposition of the steam, and gas of better quality are obtained, the higher the temperature of the fuel bed and the greater the depth of coke at the high temperature." It is common practice in America when using bituminous coal for generator fuel to fill the generator up to the charging door.

The section on "The Decomposition of the Oil" on page 18 of the Report was very interesting to me, especially the work of Hollings and Griffith on the rate of oil introduction. Last June I made some tests on increasing the rate of oil introduction as much as 40 per cent., but found no appreciable change in the oil efficiency. The tests were made on a 7-ft. C.W.G. machine equipped with a backrun. The operating results were as follows:

Oil Input Period.	75 Seconds.	60 Seconds	45 Seconds.
1	2	3	4
Fuel per MCF, pounds .	27·2	28·0	27·8
Oil per MCF, gallons . .	2·60	2·66	2·64
B.Th.U. per cu.ft.. . .	526	525	531

Simultaneous samples of gas were taken at base and top of the superheater during the oil input period. The temperature at the base of the superheater was 1,550° F. and at the top about 1,300° F. The analyses of these samples were as follows:

Oil Input Period.	75 Seconds.		60 Seconds.		49 Seconds.		45 Seconds.	
	Base.	Top.	Base.	Top.	Base.	Top.	Base.	Top.
1	2	3	4	5	6	7	8	9
CO_2	4·4	4·0	2·4	2·8	2·8	2·2	4·0	2·8
Ills.	12·0	12·6	16·6	15·2	17·4	18·0	20·0	18·0
O_2	0·8	0·6	0·8	0·4	0·4	0·6	1·0	0·6
CO	32 0	27·4	32·0	30·6	31·0	29·2	27·7	26·8
CH_4	12·1	19·3	15·0	21·6	16·1	24·2	18·0	23·7
H_2	29·3	26·8	29·4	27·6	28·2	23·5	27·8	24·5
N_2	9·4	9·3	3·6	1·8	4·1	2·3	2·5	3·6
B.Th.U., calc. .	592	657	729	749	750	856	816	814
Per cent. oil gas ills. + CH_4 . .	24·1	31·9	31·6	36·8	33·5	42·2	38·0	41·7
B.Th.U./cu ft. oil gas	1,645	1,515	1,690	1,535	1,670	1,560	1,685	1,560
Calc. H_2 due to B.W.G. . . .	37·7	32·0	36·6	36·2	35·4	33·6	35·7	31·8
Per cent. H_2 absorbed . . .	8·4	5·2	7·2	8·6	7·2	10·1	7·9	7·3

The conclusions drawn from these tests were:

(1) That at a given temperature the degree of oil cracking is not materially affected by a change in the rate of oil input.
(2) That most of the cracking occurs in the carburettor.
(3) That some additional cracking occurs in the superheater although the temperature was 200° F. or more lower than the temperature in the carburettor.
(4) That the cracking which occurs in the superheater is more harmful than beneficial. The oil cracking efficiency in therms per gallon was 8 per cent. higher at the base of the superheater than at the top.

Dr. F. J. Dent's Written Reply.

Dr. F. J. DENT (Research Chemist), in reply, wrote: Since the discussion took place I have had an opportunity, through the courtesy of Dr. J. G. King, to examine the results of the experiments made by Dr. King on purging,* and would like to amplify my spoken reply in this connection. I had the impression that Dr. King observed a loss of 18·5 per cent. of the blue water gas made, if the calorific value of the gas, understood to be the *average* calorific value of the gas collected, was not to be depressed below 290 B.Th.U. per cu.ft. by the inclusion of inerts. It now appears that the figure of 18·5 per cent. represents the proportion of up-run blue gas which was lost when the closing of the stack valve was delayed until the calorific value of the gas passing through it had risen to 290 B.Th.U. per cu.ft. In his original Paper, Dr. King appreciated that the closing of the valve would not be delayed to this extent in normal working. He concluded that, by fixing the timing of the stack valve so that the *average* calorific value of the total blue gas was reduced by 2½ per cent., the thermal loss was only 2 per cent.—*i.e.*,

* *Vide* Gas Engineer, May, 1933, p. 207.

the thermal loss was only 2 per cent. when 2-2½ per cent. of nitrogen from blow gas was permitted in the blue gas.

These figures can be regarded as substantiating those of the present investigation in which the loss on purging was estimated as 1 per cent. when 3 per cent. of nitrogen was permitted in the gas. Such losses are of small account so long as appreciable increase in output can be obtained by shortening the cycle. In this connection it is interesting to record the compositions of gases taken on the plant at Croydon during the change-over from run to blow and blow to run.

(*a*) *Samples Taken at Inlet Waste Heat Boiler.*

—	(i.) Stack Opening.	(ii.) Stack just Fully Open.
CO_2	12·8	16·0
CO	18·5	8·1
H_2	23·8	2·9
N_2	44·9	73·0

(*b*) *Samples Taken at Inlet Wash-Box.*

—	(i.) Stack Closing.	(ii.) Stack just Fully Closed.	(iii.) 1 Sec. after Stack Closed.
CO_2	12·2	8·9	6·7
CO	16·6	43·9	48·3
H_2	1·4	18·9	30·7
N_2	69·8	28·3	14·3

The stack valve took 2 sec. to open and 2 sec. to close.

Dr. King's later remarks applied to tests Series V., on the influence of the size of fuel used—in particular to the explanation given of the connection between the fuel size and the heat capacity of the reaction zone. The Report suggests that when using small coke, the reactions with air and steam occurred in a shallower depth of fuel bed due to the greater surface exposed, per unit depth, to the reacting gases. The reaction zone would, in consequence, be of lower heat capacity and would undergo wider cyclic fluctuations in temperature. It was further suggested that it was owing to these wider cyclic fluctuations that small coke gave rise to a greater percentage of carbon monoxide in the blow gas when, during the run, blue water gas of a definite quality was made and a given percentage of the steam was decomposed. The tests on the influence of blast pressure indicated that such behaviour could not be explained by a general raising or lowering of the average temperature in the fuel bed.

Dr. King maintained that loss of output when using small coke can be avoided if a greater rate of air supply is used in order to prevent an observed fall in the temperature of the fuel bed. It must be remembered however that in practice, changing to a fuel of smaller size usually requires the use of a *lower* rate of air supply due to the greater tendency of smaller fuel to be blown over from the generator. The alternative method of maintaining the output with small coke, viz., by lengthening the blow period, is discussed in the Report. The procedure is accompanied by a deterioration of gas quality and a lower steam decomposition if excessive losses of carbon monoxide in waste gases are avoided.

Dr. Griffiths' comment to the effect that no new principles have been established is received with some surprise in view of the opinions which he expressed in his recent book on water gas. In that book, Dr. Griffith confessedly finds himself unable to give definite indication of the influence of such a fundamental factor as the rate of air supply, while the present Report is in direct opposition to his views regarding the possibility of controlling the heat in the blow gases, the reactivity of the fuel used and the influence of the generator boiler, &c. It is gathered, however, from Dr. Griffith's further remarks that his opinions upon some of these factors have changed. Thus, his comment upon the method of expressing the results of coke and oil gasification as separate items, viz., " . . . this method of treatment, however, must not be carried to extremes, because there is a definite demand on the performance of the generator due to the heat required in the decomposition of gas oil "—contrasts curiously with his previous statement, "The dual processes of water gas manufacture and oil gas manufacture have been too often regarded as a single unit . . . they should be studied and controlled as separate entities . . . although they are to some extent interdependent, the circumstance is very rare that water gas efficiency has to be sacrificed in order to economize in oil." Actually, the method of regarding the water gas process in the present Report is not in agreement with either of these views. Blue water gas and oil gas are treated separately in so far as they are obtained from different raw materials. Throughout, however, close attention is given to the proper liberation, during the blow period, of heat for steam decomposition, oil cracking, and steam raising.

In his analysis of the back-run process Dr. Griffith fails to take account of all the factors involved and his deductions are erroneous in consequence His premise is that the back-run, as distinct from the down-run, increases the heat available for steam decomposition in the generator by returning heat or superheat in the back-run steam. Actually this is not the case. When using the down-run, a similar preheating of the steam occurs, but in the upper layer of the fuel bed instead of in the superheater. Thus, as would be anticipated, a calculation based on the assumption that the use of a back-run increases the amount of heat available in the reaction zone of the generator leads to wrong conclusions. As stated in the Report, the advantages of the back-run system depend upon it reducing the amount of heat required in the carburettor, in consequence of which it is possible to modify the operation of the generator. When maintaining the plant self-supporting in steam lower air/steam ratios can be used with the back-run and not, as deduced by Dr. Griffith, with the down-run.

Dr. Griffith continues with a discussion of the influence of the self-clinkering grate and generator boiler upon the output of the plant. Unfortunately he has used the results given in Table 12 as an example of the output obtained on the self-clinkering plant. As described in its context, Table 12 was compiled with a view to showing the improved fuel bed conditions of the self-clinkering set when operated at a similar output to that obtained on the hand clinkered sets considered. The fact that there are differences of output between the results in Table 12 is solely because figures for a lower output on the self-clinkering plant were not available. The outputs obtained on hand-clinkered and self-clinkering sets when operated under their normal conditions are compared in Table 18 where it is seen that the rate of gas production during the run period, per square foot, was 135 per cent. greater on the self-clinkering set and not 20 per cent., as indicated by Dr. Griffith.

We maintain the view that the chief advantage of the generator boiler is to permit a high output to be obtained. Due to the value of the steam raised and the reduction of heat losses from the generator as blow gas and by radiation, the high output is obtained without increase in the cost of raw materials. It is not suggested that further technical development will not take place, but it is thought that the success of alternative designs depends not so much upon reducing the cost of raw materials as upon obtaining a greater output without incurring high maintenance charges or frequent overhauls. With these provisos, we are in agreement with the view that the limitation of the generator boiler is desirable, since then more heat would be available for oil cracking and the difficulty of maintaining the temperature at the top of the carburettor would not be so marked.

The remarks of Mr. Webber were of especial interest to us in view of his presence throughout the tests. He appears to have reacted against the multitude of observations which were made at Croydon, but I think we are justified in pointing out that the close supervision given to the plant was more to obtain the test data than to control it along the lines proposed in the Report. In the case of the plant at Croydon, the suggested control would only involve a variation of the duration of the blow period according to the output desired and an adjustment of the rate of steam supply so that the plant remains self-supporting in steam. Once blow periods and corresponding rates of steam supply have been standardized, no one should experience difficulty in making any necessary modification of the cycle if an emergency demand for gas occurred.

We are in full agreement with the remainder of Mr. Webber's remarks except that, when he accepts capital charges as a fixed burden, it appears that he is considering only the operation of an existing plant which is of adequate capacity to meet the demand of gas from it. This was the case at Croydon. Sooner or later, however, the existing plant will require extension or replacement and then a decision must be made as to how far the output of a plant can be increased before the resulting saving in capital charges is counterbalanced by less efficient use of the raw materials. Such is the general case of water gas costs to which Mr. Webber refers.

Mr. Thomas raises an interesting and debatable point with regard to the conditions under which the tests were made. When the process of investigation involves many factors, as in water gas production, it is very doubtful whether any one set of test conditions can be regarded as the best. The choice of conditions depends largely upon the use to which the results are to be put. In the present instance, where the investigation was carried out primarily with the aim of obtaining data which would aid everyday

working, it was clearly of most importance that the test conditions should have regard to the limitations encountered in operation—viz., gas quality, clinker formation, heat requirements of oil cracking and steam raising, &c.—rather than to such conditions as Mr. Thomas suggests. Mr. Thomas himself implies that "isothermal" conditions in the fuel bed while being of theoretical interest would apply only indirectly to practice. If desired, however, the behaviour of a water gas plant under such conditions can be deduced by proper correlation of the results of the various experimental series.

The results of the tests indicate that the hourly evaporation of the annular boiler gives little guide as to the average temperature in the fuel bed. The evaporation depends also upon the distribution of temperature and, more particularly, upon the convection of heat in the bed by means of the gases and vapours flowing through it. Thus, in the experiments on blast pressure, the evaporation of the generator boiler increased by 67 per cent. on raising the blast pressure from 4·7 to 21·0 in. The accompanying increase in the temperature of the fuel bed would account for but a small fraction of this increased evaporation, which is largely attributed to the greater flow of gases through the fire and in contact with the boiler surface and the nearby coke. It is thought that the variation in the boiler evaporation in Table 14, referred to by Mr. Thomas, is due to the same cause.

The experimental thermal balance which Mr. Thomas finds lacking in the Report is indeed given in Table 19, in which item 66 represents the difference item of the balance expressed in terms of the coke supplied. It will be seen that this difference item corresponds to less than 1 per cent. of the total heat supplied as coke. A number of such experimental balances were constructed before the test methods described in the 35th Report were adopted.

The following figures are quoted as examples of the experimental values from which the tables of results have been prepared. They correspond to Table 14 of the 35th Report and show the influence of the air/steam ratio when using the normal grate speed.

Experimental Values.

Air/Steam Ratio	32·6	33·8	35·0	36·1	37·6	39·3	47·0	50·2	52·8	65·7	73·4
1	2	3	4	5	6	7	8	9	10	11	12
CO_2 in B.W.G., per cent. . . .	7·4	7·1	6·9	6·7	5·9	5·5	4·4	3·7	3·6	2·5	1·7
CO_2 in blow gas, per cent. . . .	14·5	14·4	14·4	14·3	14·1	14·0	13·5	13·2	13·0	12·0	10·6
H_2 in blow gas, per cent. . . .	0·94	0·94	1·09	1·02	1·19	1·16	1·32	1·53	1·60	1·94	2·05
Average temp. B.W.G., °C. . .	556	556	556	556	565	561	546	563	560	579	579
Average temp. blow gas, °C. . .	683	683	682	679	688	685	687	681	677	685	691

Communication No. 124—26th Report of the Refractory Materials Joint Committee.

Mr. A. T. Green, amplifying his spoken *reply*, wrote: I do thank the President for his tribute to the work of the B.R.R.A., which I intend to communicate to the Chairman and Council of the Association. It is very useful to us to have his assurance that the life of segmental silica retorts has been increased by 25 per cent. during the past ten years. My Council are fully alive to the necessity for continuing this progressive work and feel that the money subscribed by the Gas Industry will be much more than returned in the increased efficiency of gas-making plants.

Communication No. 127—The Institution Gas Research Fellowship Report; 1934-35. The Scaling of Mild Steel in Sulphur-Free and Sulphur-Containing Furnace Atmospheres.

Dr. U. R. Evans (Cambridge University) wrote: It would seem that the function of sulphur oxides in stimulating oxidation and scaling at furnace temperatures is somewhat different from promoting corrosion at low and medium temperatures, since such stimulation is found at temperatures where condensation is impossible. Some early examples were provided by the work of Hatfield* on the scaling of iron and iron alloys at high temperatures by air in the presence or absence of sulphur dioxide, carbon dioxide and water vapour (alone or in combination). An explanation for this stimulation of scaling by sulphur dioxide has been suggested.† In pure hot air, the oxidation of iron appears to be a direct combination with oxygen, which naturally slows down as the oxide-scale becomes thicker, owing to the diminished rate of supply of oxygen to the metal; but in presence of sulphur dioxide a small amount of sulphite or sulphate may be temporarily formed, which at this high temperature will at once be decomposed, producing a relatively porous form of oxide; a mere trace of this more porous, secondary oxide, in the scale, should be sufficient to render the scale as a whole more pervious to oxidizing gases and may reduce the self-stifling of the attack as the scale thickens.

Recent results, which Professor Cobb kindly allowed me to quote in a recent report on scaling,‡ appear to fit in with the mechanism suggested above. The corrosion-rate increased with the content of sulphur dioxide in the gas up to about 0·01 per cent., but beyond this point the stimulation was much less marked; sulphur appeared in the corrosion product above this critical value. This is easy to understand; as long as the sulphur compounds produced in the scale can decompose as quickly as they are produced, their effect will be to stimulate attack; when the amount of sulphur compounds in the gas is so great that sulphur compounds in the scale are produced more quickly than they can be decomposed, the further stimulation will become small, since it is not the sulphur compounds themselves, but the secondary oxide produced by their decomposition, which constitutes the pervious constituent of the scale.

Another example may be provided by the work of Hudson, Herbert, Ball, and Bucknall§ on the acceleration produced by traces of hydrogen chloride in the oxidation of copper by products of combustion; up to a certain concentration, the amount of oxidation increases rapidly with increase of the amount of hydrochloric acid in the gas; above the critical concentration, the oxidation-rate increases more slowly with the content of hydrochloric acid, and at this stage traces of basic copper chloride appeared in the corrosion-product. One possible explanation (which does not appear to be wholly accepted by the authors of that research) is that at lower contents of hydrochloric acid the basic copper chloride is duly formed, but is decomposed, giving a porous form of oxide which renders the scale more pervious to oxygen.

Professor J. W. Cobb's Written Reply.

Professor J. W. Cobb (Livesey Professor), in reply, wrote: Dr. Millett and I wish to thank the President and Dr. Hatfield for the appreciation of our work which they have felt justified in expressing. Dr. Hatfield has not concerned himself with detail in his contribution to the discussion, but has indicated very clearly and emphatically how such a study as we have attempted will render possible improvements in the design and working of furnaces by providing precise information on which such improvements may be based. There are, indeed, already working in the Sheffield district furnaces embodying such improvements, a subject dealt with before the Institution by Dr. Fells. It is interesting and useful to have the testimony of so high an authority as Dr. Hatfield, thoroughly conversant with the subject, that he can speak confidently of the advantages in a variety of metallurgical operations of using a fuel such as coal-gas which, by its cleanliness and purity renders possible a degree of precision and control otherwise unobtainable. When various fuels are considered, it is advisable to bear in mind that coal-gas is the only one in which extensive purification from sulphur compounds has been carried out, and that these sulphur compounds have a very pronounced bad effect in increasing scaling and in other directions. We wish to thank Dr. Evans for the written contribution to the discussion in which he has put forward again the explanation that he would suggest for the great stimulation of scaling by sulphur dioxide, and would like to thank him too for calling our attention to the possibly analogous case of the acceleration of the oxidation of copper by traces of hydrogen chloride. The explanation seems quite feasible, but we would rather not discuss it until the experimental work is complete, undertaken in the hope of throwing light upon the reaction mechanism.

* W. H. Hatfield, J. Iron Steel Inst., 1927, **115**, 483.

† U. R. Evans, J. Iron Steel Inst., 1927, **115**, 510.

‡ "Review of Oxidation and Scaling of Heated Solid Metals," Dept. Sci. Ind. Res., 1935, p. 14.

§ O. F. Hudson, T. M. Herbert, F. E. Ball, and E. H. Bucknall, J. Inst. Met., 1929, **42**, 221.

The Southern Association of Gas Engineers and Managers

Annual General Meeting in London, Nov. 29

The Annual General Meeting of the Southern Association of Gas Engineers and Managers was held at the Hotel Metropole, London, on Friday, Nov. 29—Mr. E. L. NICHOLAS, of Guildford (the President), in the chair.

In opening the proceedings the PRESIDENT remarked how pleased he was to see so large a gathering, especially so many members from the west—which he took as a compliment to himself, coming as he did from that quarter. He also referred with pleasure to the presence of Mr. A. Roberts, of Hereford (President of the Midland Association of Gas Engineers and Managers), and of Mr. Valon Bennett.

The PRESIDENT thereafter proposed that the minutes of the last general meeting, as published in the "GAS JOURNAL," be taken as read, and this was agreed.

The New President.

The President went on to propose the election of Mr. R. J. H. CLARK (Plymouth) to the Presidency of the Association for the ensuing year. Mr. Clark had been, he said, a very energetic member of the Association for many years. He went to Plymouth in 1903 and succeeded Mr. Hoyte, himself a Past-President of their Association, in 1928, since when he had been in charge of the Plymouth undertaking. Mr. Nicholas remarked that he had known Mr. Clark for thirty years, and he had every confidence in recommending him to them as a fit and proper person to be their President for the next year.

Mr. J. H. CORNISH (Bridgwater) seconded the proposition, remarking that Mr. Clark was one of their very esteemed members in the west and was in charge of what was probably the most important undertaking in that part of the country. He was quite sure he would fulfil the expectations they had of him and that they would find in him an able President.

The resolution was carried unanimously, and, in acknowledging his election, Mr. CLARK thanked Mr. Nicholas and Mr. Cornish for the kind words they had spoken regarding him. It was with very real pleasure that he had accepted the invitation to be their President for 1936, and he expressed his sincere thanks for this greatly appreciated honour. He recalled the fact that his first acquaintance with the Gas Industry was at the Old Kent Road Works of the South Metropolitan Gas Company, where his grandfather had served for fifty-five years. Mr. Hoyte was unfortunately unable to be with them that day, and he would like to take this opportunity of expressing his indebtedness for his unfailing kindness and help throughout Mr. Clark's professional career. When Mr. Hoyte was elected President of this Association in 1922, Mr. Clark little thought that the honour which then fell on his shoulders would fall upon his own as it had that day, and he hoped he would be able to deserve that honour.

Mr. CLARK went on to propose the election of Mr. S. E. Whitehead as Vice-President of the Association for the ensuing year, which he did with the greatest pleasure. There was little need for him to refer to his name and varied qualifications, gathered at Birmingham, Southport, Portsmouth, and Southampton. Many of them would remember the excellent Paper which he read before this Association in 1924 and his subsequent contributions. Mr. Whitehead had been a very keen member of the Association for the past sixteen years.

Mr. T. CARMICHAEL (Portsmouth) said that it gave him the greatest pleasure to second the nomination of Mr. Whitehead as Vice-President of the Association. It had been his privilege and pleasure to know Mr. Whitehead for many years, and he appreciated—as many of them did—the good work he had done for the Industry. One or two technical contributions had been referred to by the proposer, and he would mention that Mr. Whitehead was also the Author of a book entitled "Benzole," as well as being a prize-winner in the Woodall-Duckham competition for his Paper on Coke Preparation. He had therefore supplied the Gas Industry with some very useful contributions, as well as being a loyal and hard-working executive officer of the Southampton Company.

The PRESIDENT intimated that Mr. Whitehead was unfortunately prevented from being with them through indisposition, and on putting his election to the meeting, it was carried unanimously.

Officers for the districts were then announced as follows:

Eastern District Committee, 1936.

Chairman.—Mr. D. F. Irving.

Vice-Chairman.—Mr. G. R. Bullwinkle.

Committee.—Messrs. C. V. Bennett, W. H. Bennett, C. F. Botley, G. R. Bullwinkle, T. Carmichael, *R. J. H. Clark, D. C. Cross, J. H. Donaldson, G. Le B. Diamond, H. Gage, W. Grogono, J. F. Haseldine, L. G. Humphrys, J. H. Hornby, *W. A. Howie, D. F. Irving, S. Lacey, L. J. Langford, E. L. Nicholas, F. J. Robinson, R. H. Ruthven, W. J. Sandeman, E. F. Smallbone, H. C. Smith, A. W. Sumner, L. Trewby, W. H. Warren, and *S. E. Whitehead.

* Members *ex-officio* (Rule 9).

Hon. Secretary.—Mr. W. A. Howie.

Representatives to Main Association.—Mr. T. Carmichael, Mr. G. R. Bullwinkle, Mr. F. J. Robinson, and Mr. G. Le B. Diamond.

Representatives on the District Education Committee of The Institution of Gas Engineers.—Mr. G. R. Bullwinkle, Mr. H. Gage, Mr. S. E. Whitehead, and Mr. D. C. Cross.

Western District Committee, 1936.

Chairman.—Mr. J. H. Lowther.

Vice-Chairman.—Mr. H. Higham.

Committee.—Messrs. F. Blackburn, *R. J. H. Clark, J. Hughes Cornish, J. B. Cattle, W. E. Dean, R. S. Falkner, S. E. Halliwell, C. Harris, H. Higham, *W. A. Howie, P. S. Hoyte, S. J. Ingram, J. H. Lowther, J. H. Pye, E. Samuel, C. Stapleton, J. Taylor, R. C. Taylor, A. Thomas, H. W. Versey, W. N. Westlake, and *S. E. Whitehead.

* Members *ex-officio* (Rule 9).

Hon. Secretary.—Mr. J. H. Cornish, Junr.

Representatives to Main Association.—Mr. A. Thomas and Mr. F. Blackburn.

Representatives on the District Education Committee of The Institution of Gas Engineers.—Mr. C. Harris, M. J. H. Lowther, Mr. R. Robertson, and Mr. W. N. Westlake.

On the proposition of Mr. F. J. ROBINSON (Chesham), seconded by Mr. L. J. LANGFORD (Tunbridge Wells), the Association's Hon. Auditors (Mr. J. Donaldson, of Southborough, and Mr. J. Urquhart, of Dorking) were unanimously re-elected, the latter gentleman briefly acknowledging this renewal of their confidence on behalf of Mr. Donaldson and himself.

In proposing the re-election of Mr. W. A. Howie, (Gravesend) as Hon. Secretary of the Association, the PRESIDENT remarked that last year some doubt was expressed as to whether it was right for one man to take on both the Secretaryship of the Association as well as of the Eastern District; but as President he could assure them that the Association had not suffered by it however Mr.

Howie himself might have. Presidents came and went, receiving their share of the limelight, but the Secretary's duties were carried on efficiently and quietly in the background. This year Mr. Howie had been of tremendous help to him, and he had great pleasure in moving his re-election.

Mr. CLARK seconded the resolution, which was carried unanimously, and Mr. HOWIE expressed his thanks for the honour they had conferred upon him in asking him to continue in this office.

New Members.

The following new members were elected:

E. J. Luff (Commercial Gas Company).
G. H. Kenyon (Folkestone).
H. S. Moore (Okehampton and Bude).

Presentation of Certificates.

Certificates were then presented by the President to successful candidates (resident in the area of the Association) in The Institution of Gas Engineers Examinations in Gas Engineering and Gas Supply. The complete list of successful candidates is as follows:

EXTERNAL HIGHER GRADE GAS ENGINEERING.

1st Class.	A. D. L. Copp	London, S.E. 15
2nd Class.	G. E. Banner	Margate
,,	N. T. Brake	Southampton
,,	T. W. Clapham	Bristol 6
,,	G. Fitton	Thrupp, Gloucester
,,	A. J. L Gamper	Purley
,,	J. R Martindale	Bristol
,,	A. C. Shilson	Weston-super-Mare

INTERNAL HIGHER GRADE GAS ENGINEERING.

1st Class.	N. Calvert	Tottenham, N. 17
,,	F. Dawson	London, N.W. 11
,,	A. Lacer	Bristol 8
,,	J. M. Hawes	Mill Hill, N.W. 7
,,	E. B. Marriage	Tottenham, N. 17
,,	W. K. Tate	Stanmore, Middlesex
,,	J. M. E. W. Webber	Croydon
2nd Class.	A. E. Chorley	London, S.W. 4
,,	A. F. Grant	London, S.E. 3
,,	E. H. Richmond	Catford, S.E. 6
,,	T. G. Spalding	London, S.W. 3

EXTERNAL HIGHER GRADE GAS SUPPLY.

1st Class.	A. D. L. Copp	London, S.E. 15
,,	L. A. Ross	Portsmouth
2nd Class.	J. S. Fox-Andrews	Bristol
,,	W. J. Offen	Ramsgate
,,	H. J. Patching	Deal

INTERNAL HIGHER GRADE GAS SUPPLY.

1st Class.	C. H. Atlee	Brentford
,,	H. G. Clarke*	Hanwell
,,	R. F. Coltman*	Tottenham, N. 17
,,	F. G. Cooper	Wood Green, N. 22
,,	G. N. Critchley	Blackheath, S.E. 3
,,	L. G. Fry	Enfield Wash
,,	C. C. Holwell	London, N. 7
,,	J. Huskisson	Buckhurst Hill
,,	H. H. Muggleton*	Acton Hill, W. 3
,,	G. W. A. Parker	Tottenham, N. 17
,,	C. O. M. Priday	Blackheath, S.E. 3
,,	E. J. Spurrier	Maida Vale, W. 9
,,	R. E. L. Tennyson D'Eyncourt	Eastcote, Middlesex
,,	R. A. Woolidge	Forest Hill, S.E. 23
2nd Class.	G. F. Bedford	Wandsworth, S.W. 18
,,	A. R. Birch	London, W. 8
,,	G. H. R. Coulden	Cricklewood, N.W. 2
,,	G. R. S. Cusins	Blackheath, S.E. 3
,,	C. Fishlock	London, N. 9
,,	S. J. Gibbons	Ealing, W. 5
,,	S. C. Harding	Richmond
,,	N. L. Henson	Hatch End, Middlesex
,,	J. W. Hulbert	Manor Park, E. 12
,,	W. H. Kohlbeck	Hammersmith
,,	W. F. W. Lewis	New Malden
,,	D. G Mead	London, S.W. 5
,,	R. G. Palmer	Loughton
,,	S G. Unite	London, W. 2
,,	J. C. Vinten	Westbourne Park, W. 11
,,	F. A. Waterman	Wanstead

* With distinction.

The PRESIDENT remarked with gratification upon the large number of successful candidates from this area. The Association congratulated them all very heartily on their success.

A Paper was then presented by Mr. G. L. Braidwood, Assistant Engineer at the Beckton Works of the Gas Light and Coke Company, on the subject of "Steaming in Horizontal Retorts," and an extract from this, together with a report of the discussion which followed, will be found on later pages of this issue.

Vote of Thanks to President.

At the conclusion of the meeting a very hearty vote of thanks to Mr. Nicholas for presiding over them was accorded on the proposition of Mr. H. GAGE (Wandsworth), in response to which the PRESIDENT observed that when, two years ago, he had been asked to take office he had accepted with the greatest diffidence. But that feeling had gradually disappeared, and the friendliness, loyalty, and help he had received from all of them had made it a very happy year.

Gas and Coke Utilization in Modern Buildings

A report of the joint Discussion which followed the Papers by Dr. F. M. H. Taylor and Mr. W. L. Boon at the Gas Industry Session of the Public Works, Roads, and Transport Exhibition at the Royal Agricultural Hall on Nov. 19. Extracts from the Papers were published in last week's issue.

Mr. R. J. RESTALL (Stalybridge Corporation Gas Department) said that coke as produced to-day was most suitable for modern buildings. The fuel in itself, of course, was many years old, but the quality to-day was typically modern. It was claimed with justifiable pride that the Gas Industry was the premier service industry in the country, and it was acknowledged that that Industry had distinctly risen to the occasion in supplying the cleanest solid smokeless fuel procurable. Within the last few years the problem of providing the fuel so obviously demanded had been dealt with, and by the apparent interest and more so by the increase in sales, particularly of graded coke, it was believed that the problem had been tackled successfully.

The first thing necessary, created by demand, to receive the attention of the Gas Industry was the grading and sizing of coke. Screens had been placed in all the gas-works of the country which dealt with grading and in some cases dealt exclusively for local requirement. From this the movement went on to the cleaning of coke, and by cleaning was meant the removal of the smalls and dust—*i.e.*, breeze—which was, of course, of lower money value. This, however, provided fuel which did not clinker. The breeze was used for the firing of industrial steam boilers where forced draught systems were in operation, and it was a valuable addition in assisting the electricity generating industry in lowering their already high costs and over-burdened expenditure.

Consequent upon the demand for clean coal to produce low ash content coke, the colliery owners had yielded to the continual pressure of the Gas Industry and were now supplying coals with low ash content and free from dirt by washing processes. This was an advantage to the carbonizing industry and enabled it to pass on to the users of this smokeless fuel 90% of solid and gaseous combustibles. This was a distinctive movement and directly affected the finished product inasmuch as the value could be accurately assessed from the analysis of the fuel. This lowering of the ash content to about 8% was undoubtedly an achievement, but the Industry was not content to rest, and the latest development was in the direction of supplying dried or low moisture content coke. Most gas-works were supplying coke of such a quality, and it very rightly might be described as the true modern solid smokeless fuel.

One of the biggest problems this country had to face was how to bring home the importance to the Government—because after all it must be a Government job—of the true national aspect of the use or mis-use of coal. American and Continental towns and cities had long ago realized the importance of burning smokeless fuel, but in England, although they were perhaps slowly advancing, they were yet relatively in the same position as they were 15, 20, and 30 years ago. Nobody apparently had yet discovered the way to bring what might be termed the disaster of burning raw coal fully before any Government that had been in power. The trouble, of course, was obvious, but if only the economics of the situation were

fully considered by an expert Commission, then would be realized the necessity of using coal in the most efficient manner, which was—and it could not be confuted—carbonization. Whether it be low temperature or high temperature, the production of gas and coke could be brought to such a pitch as to provide the whole of the heat required for every process in the country, including the generation of electricity.

A careful study of the Paper by Mr. Boon, together with experience of practical application, must convince fuel buyers that in a large number of cases coke was the ideal fuel. Although he was a member of a gaseous fuel industry producing solid smokeless fuel, he recognized there was a place for both, because the Gas Industry was above all things a service industry, and it should be appreciated that it was their endeavour to place before users the right fuel for the right work. In laying themselves out by expenditure on plant and research and investigation to give this service and a high-class fuel, the Gas Industry was obviously convinced of the possibilities and necessities. In this the London and Counties Coke Association, in bringing to successful fruition in a relatively short time such a body as was now able to serve London and the Home Counties with three million tons of coke each year, was an example of the service which the Gas Industry was rendering, and he sincerely hoped that this example would be followed by all coke producers. By the activities of the Association, advice regarding correct appliances and their respective fuel sizes was freely offered; further, one of the most desirable functions of this Association was the control, stabilizing, and levelling of prices. Keen competition to-day demanded similar area pricing for the commodities offered by the Gas Industry; to-morrow there might be a need for national price levels.

In the Interests of the User.

The PRESIDENT (Colonel W. M. Carr), remarking that they were all makers of gas and coke, said they often had to decide which should be advised in the best interests of the user. From the point of view of the open fire there was no question in his mind that coke of the right quality and properly graded was the ideal fuel of the future. There was no doubt, also, that the use of gas was complementary to the use of coke in the open grate. In other words, gas was the ideal ignition for coke at least in an open grate. Many had been concentrating on the production of coke which was low in moisture and which had a very low ash fusion temperature. These were two essentials for an ideal coke for use in the open grate, and while many undertakings were producing an ideal coke for the open grate there were still a considerable number producing large quantities of coke which was too high in moisture and which had a low ash fusion temperature. It would be interesting to hear what Mr. Boon had to say on the quality of the ash as distinct from the quantity, because it appeared to him that for certain purposes, such as bakers' ovens in particular and slow-burning stoves or hot water boilers which had to be maintained continuously fired for week after week and slowed down at night, the question of the nature of the ash, as far as fusion temperature was concerned, was of paramount importance.

On the question of utility and availability, when it came to central heating he believed future development was going to be largely with gaseous fuel. Personally he was trying hard to displace coke by gas, for he believed gas to be much better from the point of view of automatic control, overall efficiency, and the economic aspect, particularly where it was sold on a heat value basis. The great market for coke would be in the open grate, in industry for various uses, but in his view in the field of central heating gas was particularly suited. This was being appreciated very widely in America, where there was an extensive conversion of stoves to gas, and the installation of many new gas-heated central heating appliances in place of solid fuel. This was being done in conjunction with thermostatic control, and the economy could not be disputed. As an instance, he would mention the case of a school with which he had had to deal. It was true that the school had not previously been heated by means of a gravity feed automatic boiler such as that indicated by Mr. Boon, and therefore it did not represent the highest possible efficiency that was attainable with coke for central heating. It was heated with a sectional boiler of the usual type. In the course of the experiment figures were taken over a whole year with coke firing—*i.e.*, room temperatures, and particulars were also taken of the occupancy of the rooms in relation to the temperature in order to assess what was being received from the bodily heat of the occupants. Having got a year's figures with coke, the boiler was replaced by gas, retaining the same heating installation with a clock control for automatically starting up in the early hours of the morning. The net result was that with coke at 22s. per ton—and the school in question was near the coalfields, so that the price of fuel was substantially lower than in other places—and gas at 3½d. per therm, the fuel cost of heating by gas—disregarding labour costs—was actually 5% less than with coke. There was also another factor; not only was the fuel cost 5% less but the heating conditions were very much better with the automatic and thermostatically controlled boiler than they had been with the coke-fired boiler. Possibly Mr. Boon would say that this comparison would be very different if there had been an automatic gravity feed coke-fired boiler; notwithstanding that he believed that, taking everything into consideration and the fact of utilizing clock control, it was possible to have the rooms at exactly the desired temperature when the children came in in the morning. The automatic control of the boiler worked so well that the rooms never exceeded the desired temperature by more than a very small percentage, whatever the outside temperature conditions were. Gas showed definite advantages.

Mr. WILLIAM DUNBAR (Kilmarnock) said that as a municipal engineer he had been particularly interested in the Chairman's description of his experiment with a school. It had been his own lot a fortnight ago to be asked by his local authority to report on the heating of a small public building, and as the gas undertaking was municipal he wanted to employ gas if it was at all possible. Therefore, to be absolutely fair to gas he invited the gas manager to discuss the matter with him and co-operate in the preparation of the estimate. Unfortunately, however, the gas manager did not make out a very good case, financially, for gas. All the points mentioned in Dr. Taylor's Paper were considered one by one, and a point of particular interest was the statement in the Paper that with gas central heating boilers no labour or attention was required. The three problems considered in this particular case were the ordinary gas-fired boiler, the coke-fired boiler, and the mechanically stoked boiler using a cheap fuel known in Scotland as gum. It so happened that the labour problem did not enter into the matter because the labour was available in any case. He agreed with the second point made by Dr. Taylor as to the absolute cleanliness of gas, which, of course, included the point that there was no ash. As to the point that the gas-heated boiler required only a very small space and did not require any fuel storage space, he admitted that these were decidedly an advantage to gas. With regard to a flue, the only position possible for a furnace in this particular case was such that it would be very difficult to get a satisfactory flue, and therefore gas had a distinct advantage in this respect. With regard to the accuracy of control and flexibility of gas-fired boilers the gas manager worked it all out for thermostatic and clock control with the following results: The gas manager put the cost of fuel, with gas, at £138 per annum. The boiler unit had a capacity of 625,000 B.Th.U., not a very big boiler. With coke the fuel cost was estimated at £60 and with the mechanically stoked boiler using the gum referred to, the cost of fuel was estimated at £35. In the matter of capital charges the cost with the coke-fired boiler was about £475; the gas-fired boiler for the same work was estimated at £550 after making allowance for certain economies in boiler house, flues, &c., while the mechanically stoked boiler in the matter of capital charges was estimated at £640. It was further estimated that the annual running costs with coke at £1 2s. 6d. per ton would be £120 for the coke-fired boiler, £200 for gas, and £100 for the mechanically stoked boiler. A final decision had not yet been come to, but the matter was to be further considered during the following week and he had come to this meeting in the hope that somebody would be able to assist him in his desire to adopt gas. Incidentally, while the cost of coke was £1 2s. 6d. per ton the cost of the coal which would be used was only 8s. per ton, while the charge for gas varied from 3s. 3d. per 1,000 cu.ft. down to 2s. 5d. Finally, Mr. Dunbar mentioned that he had recently installed a gas-fired central heating scheme which was estimated to have an annual cost of £60, but in actual fact it turned out to cost only £28 in the first year.

Mr. E. N. ACKERY (British Electrical Development Association) speaking on the question of central heating and thermal storage said he did not think electricity had been given a square deal in Mr. Boon's Paper. The point he wanted to make was that there were certain costs given there which were said to be annual running costs for a daily heat output of 25 million B.Th.U. Would Mr. Boon say whether these results were actual results from tests on an installation or were they merely estimated results because, speaking from memory, the figures appeared to be exactly the same as certain figures which appeared in a booklet issued very shortly after one of the first installations using the magazine type of boiler had been completed. These figures were published before that installation had been running for a period of twelve months or even for any heating season, and he was wondering if the figures now quoted were estimates or actual results. If one worked out the efficiency of the coke boiler it was about 74·5% while the efficiency of the electrical plant for the same service was 98%. The whole question of using electricity for central heating turned on the fact of continuous or intermittent occupation. If a building was only occupied for eight hours of the day, and electricity was used, obviously it was only necessary to use electricity for eight hours a day *plus* a heating up period in the morning, whereas with a coke-fired boiler unless it was let out at night—which was more or less impossible—the boilers had to be banked for 16 hours as against eight hours of actual use. Therefore, he submitted that in a comparison of this character for a building which was not occupied continuously it was necessary to adopt some other basis of comparison than boiler efficiency. It was no use saying that a coke boiler gave an efficiency of 75% if a large quantity of the heat was being wasted during the night when it was not wanted in the building. The Chairman had introduced a rather interesting point when he suggested that in the future gas would be used for central heating because of the possibilities of thermostatic control and consequent economy, and undoubtedly that point came in very much. The gas boiler could be turned off at night and result in considerable economies; and it was just this sort of economy with thermal storage which made thermal storage plants a practical proposition for heating buildings where the occupation was intermittent, by which he meant buildings of the office type that were only occupied for eight hours a day and 5½ days a week.

Solid Smokeless and Gaseous Fuels.

Mr. S. B. CHANDLER, in a written contribution on Mr. Boon's Paper, said it was a little surprising that the use of soft coal for domestic purposes had persisted for so long. Many millions of tons were still utilized by the general public for household purposes—in many cases most wastefully—and a great deal of work of an educative character had still to be done so that by the universal adoption of solid smokeless or gaseous fuels the smoke nuisance might be completely eliminated. It was encouraging to note that year by year smoke production *via* the medium of the domestic chimney was gradually declining—very slowly perhaps, but surely—thanks to the use of coke, gas, and electricity. Gas was very extensively used by the present generation for cooking, washing, and warming purposes, and the essential services of a large number of houses in town and country were now catered for by fuels which under combustion did not produce smoke or solid residue. The average buyer of coal had little conception as to what he purchased so far as calorific content and service was concerned, nor did he realize how inefficient the return in useful heat might be. In the case of the ordinary coal fire an over-all thermal efficiency of 30% could be considered generous. The Gas Industry in particular was doing a great public service by producing and marketing carefully graded and sized high-temperature coke specially suitable for industrial and domestic boilers and applicable to the comprehensive range of coke grates now available for general use. The introduction of the gas ignited coke fire represented a comparatively new use for coke, and the increasing business being done was testimony to its utility and popularity as a means of lessening air pollution and smoky conditions. Gas, electricity, and many types of semi-cokes—the results of low-temperature carbonization, were also contributing their quota to the attainment of this very desirable end. One could quite reasonably visualize the day, not far distant perhaps, when the wholly smokeless home and factory would be quite common and the use of raw coal relegated to the past, being dealt with in the only really sensible way at present known—namely, by carbonization—so making possible not only the production of coke and gas but the availability of those by-products so essential to the welfare of the nation. Indications pointed to an awakening of public interest and support. Coke was extensively used in the production of domestic hot water and must be regarded as a most convenient means of obtaining this service. A useful adjunct was the connecting up to the circulating system of a gas heater for use during summer months or at times when the coke boiler was not in use. Many installations of this kind existed rendering good service at moderate running and maintenance costs. Undoubtedly the coke boiler and coke fire were the most economical propositions in the production of hot water and warmth in the home.

Efficiency and Fuel Costing.

Reference was made in the Paper to the efficiency of coke as a boiler fuel, and a case was mentioned in which coal of a higher calorific value than coke and costing 26s. per ton was, in point of useful work done, found to be quite as expensive as coke with a lower calorific content at 30s. per ton. He referred particularly to this point as it emphasized the fact that it was not the cost of fuel which mattered so much as the results to be obtained in use, and the Author had given very excellent reasons why in the case of coke these results might be achieved. Attention was also called by Mr. Boon to the need for sufficient aeration of the fuel bed by the provision of widely spaced bars. To the non-technical man the fact that the chief function of fire bars was to hold the fuel in suspension, as it were, so that it might be well aerated for efficient combustion and removal of ash, was sometimes forgotten. Reference was also made in the Paper to fusion and the formation of clinker, the assumption being that this was closely related to fusion temperature of the ash. Mr. Boon's experience, however, seemed to show that this was not so and that when proper control was exercised the trouble was not likely to occur. Perhaps Mr. Boon would amplify this point and advise the proper steps to be taken to avoid the trouble.

In connection with intelligent control of stoking, much depended upon the stoker, because his treatment of the plant could make or mar any installation. Owners of boiler plant should realize just what this meant and make a study of the pros and cons and avail themselves of the advice of such a body as the London and Counties Coke Association. Many of the troubles ascribed either to plant or fuel might possibly be traced to "the man behind the shovel."

Gas lighting had been dismissed by Mr. Boon in a very short sentence, but it should be borne in mind that a gas illuminated factory materially assisted the heating units and might quite conceivably affect the size of the plant to be installed. On the question of coke fires, it would be useful if Mr. Boon could say whether any consideration had been given to the size of fire relative to room content. Rooms often had a fire of too large capacity although in others the fire was too small. The efficiency of the back-boiler seemed to be higher when coke was used due to cleaner surfaces and the more intimate heat transference. Data on these points would be very useful to those engaged in sale and installation. It was hoped that with an extension of knowledge on the part of industrial and domestic consumers, the use of smoke producing coals would progressively decline, and in this respect the Association with which Mr. Boon was connected was doing extremely valuable work in the spreading of information of real utility, the dissemination of sound advice, and the encouragement of public opinion in a direction which definitely affected the welfare of the community.

Mr. J. L. MUSGRAVE said that Dr. Taylor's Paper was full of valuable information and in offering his congratulations he would like to support his remarks regarding the merits of the combination of a central heating system with local heaters for residential buildings; they were practical as well as psychological. Two equipments were slightly more expensive to install, but to maintain a building at a mild temperature in the neighbourhood of 55° to 57° F. was not particularly costly, and the temperature of the occupied rooms might be brought to the comfort range quickly and cheaply when desired. This method, which prevented overheating, would facilitate the elimination of the cold bathroom, so dear to the English heart, which was the foundation of many of the rheumatic diseases, the extent of which was causing considerable anxiety to the medical world at the present time. The moisture absorbed by the bedding, the carpets, and the structure during the process of "airing" a bedroom on a normal winter's day was astonishing; in a room too cold to sit in we undressed, exposing our bodies to radiation from the cold walls, and then jumped into a bed from which by the heat of their bodies they had to evaporate a considerable amount of water. The heat required might be in the region of from 2,000 to 5,000 B.Th.U.—much more than could be replaced by a hot water bottle. He was grateful to Dr. Taylor for assisting in the important task of educating the public that a *warm*, as distinct from *hot*, building was compatible with good health as well as comfort.

Dr. Taylor Replies.

Dr. TAYLOR, replying to Mr. Dunbar in connection with the school he had mentioned, said he was always meeting the suggestion that labour costs should not be taken into consideration because the labour happened to be there in any case, but when the matter was gone into in detail it was found in most instances that the caretaker or whoever he might be could not carry out the duties within his ordinary work and had to work overtime at anything from 1s. to 1s. 4d. per hour, which came to a not inconsiderable amount at the end of the year and ought to be taken into the comparison. The use of small coal at a cheap price had also been mentioned by Mr. Dunbar, but here again he had found that estimates based on the use of this fuel were not always accurate. This had happened in connection with a large new property in London, and eventually a coke plant was installed. He enquired of Mr. Dunbar whether in his estimates he had made provision for the maintenance of the stoker.

Mr. DUNBAR said he had allowed £5 a year.

Dr. TAYLOR said he would go so far as to say that with coal at 8s. per ton there was something to be said in favour of using that fuel, but there was not very much coal suitable for heating buildings in London which could be obtained under 28s. per ton. An interesting point had been touched upon by Mr. Ackery as to the amount of time a building was occupied compared with the shut-down period, and the point made by Mr. Ackery did not apply to a building in which the boilers were on all the time, whatever the method of firing. Quite recently he had had a talk with the man responsible for quite large building properties in London who about a year ago had considered the use of gas for his own private house. This man had asked for a definite figure of cost for using gas in his house for all purposes and so satisfied was the Gas Light and Coke Company, which was then considering a two-part tariff with a charge of 4d. per therm, that a quotation of £45 per annum was given. It was not accepted, but since then he had ascertained that the coal bill in this particular house was costing £60 a year; so that this individual was actually losing £15 a year. A point of interest in this comparison of various forms of heating was illustrated by the newer method being put forward for heating, particularly in the modernization of city offices where there had been in the past nothing more than a few coal fires and where it was now wished to have some form of centralized heating, the cost of which could be included in the rent. This method did away with a central heating plant with pipes and radiators, as it consisted of a convector type of heater which could be fitted to the rooms. In one particular building 200 of these would be installed and the heating was partially by radiant heat and partially by convected heat, and it could be thermostatically controlled. The over-all efficiency, including radiant and convected heat, was something like 70%, with, of course, no pipe losses such as existed with a central heating water system, whatever fuel was used.

Mr. Boon's Reply.

Mr. BOON, in the course of his reply, said he was very grateful to Mr. Restall for bringing out so prominently the question of quality. There was a bad legacy in coke which had been handed down from 20 years ago when it was so much regarded as a by-product which was exceedingly difficult to sell. The position to-day was vastly different, but sufficient appreciation was not yet given to the fact that during the last five years a sum of no less than £1,500,000 had been spent by the London and Counties Coke Association in improving the qualities of coke. Reference had also been made to the regulation of coke prices, but experience had shown that this was fundamental, although it would undoubtedly fail if such regulation was not equitably distributed. The Government had said in effect that the coal industry must set up a selling organization or the Government would do it itself, and the position with regard to coke was that the London Coke Association had adopted this policy already. The very best answer to this policy was that last year the Association had increased its output by 400,000 tons, and in addition 1½ million tons of furnace coke had been

disposed of in the same area. In this connection Mr. Boon said there is little doubt that the public is becoming alive to the importance of the smoke abatement question and it was now being shown how easily possible it was to make a smoke producer into a non-smoke producer by the use of suitable burning appliances and coke. With regard to the question of ash mentioned by the President, a fundamental of the burning of coke was that it should be free-burning. If there was a wider spacing of the firebars clinker would not be formed in any troublesome degree. It should also be borne in mind that the temperatures at which clinker was formed varied enormously, and from that point of view careful control of the rate of combustion per square foot of grate area was necessary. He entirely agreed with the President that eventually gas would be used completely, but it would be a long time before that came about, although it was the ideal. In the meantime the best possible use should be made of coke.

In the instance mentioned by Mr. Dunbar in which the operating costs for coke were £121, gas £200, and coal with a mechanical stoker £100, the difference in favour of coal was only £21, but the capital cost represented a difference of £165 which was against the mechanical stoker installation. This was eight years' purchase which was not to be considered a particularly good investment. Moreover, in the mechanical stoker equipment there was moving mechanism, which required more attendance and maintenance, and if that had not been taken into account the coke plant was likely to be the cheaper. In any case in the matter of running costs there was only a difference of £21 in favour of the mechanical stoker, and this depended upon the ability to obtain coal continuously at 8s. per ton, which was not very likely. In reply to Mr. Ackery, the figures referred to by him were actual figures and not estimates, and he made the statement very positively that electric heating could never compete with coke because fundamentally and economically it was impossible. In his view electricity was not a logical fuel for heating. The relative size of stoves for burning coal and coke, mentioned by Mr. Chandler, was undoubtedly a matter worth looking into, because a stove which gave sufficient heat when using coal would be found to give probably too much heat when coke was used, and a person sitting in an armchair in a similar position would then find the conditions uncomfortable. At the same time he contended that a coke fire warmed the whole of a room far more comfortably than a coal fire.

Vote of Thanks.

Mr. CHARLES F. BOTLEY, proposing a vote of thanks to the authors, expressed the hope that Mr. Dunbar, as the result of the discussion, would be able to form some satisfactory conclusions with regard to the particular fuels. A point which appealed to him was that if they could develop into a smokeless fuel age it would have the result that more gas would have to be made and therefore, in turn, gas could be supplied more cheaply than it was to-day; especially as the Gas Industry had the opportunity of introducing two-part tariffs.

Col. H. W. WOODALL seconded the vote of thanks and the meeting closed.

A Board of Trade Enquiry

Developments at Dunstable

At the Dunstable Town Hall on Tuesday, Nov. 26, Mr. J. F. Ronca (Director of Gas Administration) held an enquiry into an application by the Dunstable Gas and Water Company for a Special Order under the Gas Regulation Acts, 1920 to 1934. The enquiry was largely of a formal character since such slight opposition as existed at one time was withdrawn.

Dr. BLYTH (Parliamentary Agent), who appeared for the Dunstable Company, together with Mr. Henry Woodall (Director) and Mr. H. C. Smith (Chief Engineer of the Tottenham and Dunstable Companies), explained that the object of the application was in respect of additional lands for the manufacture and storage of gas, the land in question adjoining the present gas-works. Although the Dunstable Company was incorporated as a statutory undertaking in 1871, continued Dr. Blyth, the gas-works were considerably older because the original Dunstable Gas and Coke Company was formed under a deed dated June 1, 1836. The limits of supply of the Company were the Borough of Dunstable and certain adjoining parishes, one of which had been taken out of the Company's area by the Dunstable Gas and Water Act, 1912. The gas-works were situated at the north end of the town close to the railway station, and the capital of the Company was, by Act of Parliament, kept distinct as between the gas and water undertakings, separate accounts being kept. Land adjoining the gas-works which had originally been used for the purpose of a pumping station in connection with the water undertaking had been abandoned for that purpose in 1912, and was taken over for the purposes of the gas undertaking for general purposes but not for gas manufacture or storage. In 1935 the management of the Company was taken over by the Tottenham and District Gas Company, and Mr. H. C. Smith, the Chief Engineer of the Tottenham Company, became the Chief Engineer of the Dunstable Company. The area of land in the hands of the Company for gas-works purposes originally was 1·817 acres, and since then there had been added the portion formerly used for the water pumping station, amounting to 0·409 acre, making a total of 2·26 acres. The present application asked for powers to manufacture and store gas on an area of land now in the hands of the Company adjoining the works amounting to 1·174 acres and also another strip adjoining the old water pumping station, and if the application were granted it would give the Company a total area of gas lands amounting to 3·941 acres, and Dr. Blyth suggested that that was not an unreasonable amount for such a Company. The capacity of the carbonizing plant at present was 450,000 c.ft. per day, the capacity for gas storage was 200,000 c.ft., and there were facilities for storing 350 tons of coal, or three weeks' supply. The coke storage was 350 tons. In 1934, the maximum daily output was 287,000 c.ft., but up to date in 1935 this had increased to 312,000 c.ft. The Engineer's estimate for the whole of 1935 was 350,000 c.ft. as the maximum daily output. The storage was substantially below the maximum day's demand, and therefore new storage accommodation was urgently needed. So far as carbonizing plant was concerned, there was sufficient capacity on the present area to meet the present maximum output; indeed, a substantially larger maximum daily output could be accommodated, but the Company was faced with a very marked increase in demand, and it was necessary to look ahead and make the necessary provision. During each month of 1935 there had been an increase in demand, and at the end of October, 1935, that increase represented 9·8% over the position in October, 1934. It was pointed out to the Director that the Company had not had any increase in land for gas manufacture and storage for 64 years, although, if the old water pumping station site was taken into account, it was 23 years. On December, 1934, the number of consumers was 3,493, but on September, 1935, that figure had increased to 3,967, so that in 9 months there had been an increase of 13·6%, and in addition to this there was every sign that there would be an increase in the consumption per consumer. The old management of the Company had not introduced showrooms into the area, but with the change of management a much more progressive policy was being pursued; and although the Tottenham Company had only taken over the management a short time ago, already there had been opened temporary showrooms.

Speaking of such opposition as there had been to the proposal of the Company, Dr. Blyth referred to a petition signed by 17 residents in a road close to the gas-works in which objection was taken to the erection of additional "gasometers or cylinders and machinery" which it was said would obstruct the air space and view from the houses adjacent to the Company's lands. In connection with this, it was pointed out to the Director that in 1924 there were no houses near the gas-works, so that the houses which now existed had come to the gas-works, and not the gas-works to the houses. At the same time, he expressed strong doubts, having regard to the general position of the property in question, whether there could be any obstruction of view and air space, the nearest point of the land in question being 90 ft. away from the houses. Finally, Dr. Blyth said the sole object of this application was to re-organize and improve the gas supply in Dunstable.

Mr. *H. C. Smith* gave evidence confirming the statements made by Dr. Blyth and the figures that had been mentioned. He added that he had received information concerning plans having been deposited for the building of 3,000 houses in Dunstable and district, and this would lead to an extremely rapid development in the demand for gas. The present number of houses in the area was between 3,000 and 4,000.

In answer to the DIRECTOR,

Mr. *Smith* said that the increase in consumption mentioned by Dr. Blyth was due to new consumers and also to the installation of cookers, wash boilers, and water heating.

Continuing, Mr. Smith, said that when the Tottenham Company assumed control in March, 1935, there were no showrooms in Dunstable, but the establishment of the temporary showrooms in May had resulted in a large increase of business.

Speaking of industrial consumption, Mr. Smith said there had been a substantial increase in the last few years and that was likely to be considerably added to because there were many suitable sites for factories, and there was a tendency for firms to leave the Midlands and come farther south. For instance, the A.C.-Sphinx Company, makers of sparking plugs for motor cars, had come into Dunstable recently and taken a large supply of gas.

Mr. H. V. ROBINSON, one of the householders in question, said that when the petition was signed it was not appreciated that the Company already owned the land on which powers to manufacture and store gas were now being asked, and therefore he withdrew the objection. At the same time he said he personally objected very strongly to the smell which came from the gas-works and added that it would be very unpleasant if by the proposals of the Company this was to be increased.

Mr. *Smith* remarked that of course it was always the object of the Company to carry on the works with as little inconvenience to the surrounding district as possible.

The enquiry then closed and the DIRECTOR subsequently visited the gas-works.

Steaming in Horizontal Retorts

by

G. L. BRAIDWOOD

(Assistant Engineer at the Beckton Works of the Gas Light and Coke Company)

From a Paper read before the Southern Association of Gas Engineers and Managers at their General Meeting at the Hotel Metropole, London, on Friday, Nov. 29.

During the past two years the subject of steaming in horizontal retorts has been one of renewed interest to those responsible for controlling this type of carbonizing plant. For, although it had been tried in several cases spasmodically, and perhaps rather haphazardly, during a number of years previously, nothing sufficiently striking in the way of improved results or practical application had been achieved to create a general interest in the subject.

It is understood that steaming was tried at Beckton before the War, but details are not available. An experiment was carried out in one of the retort houses in 1921, and during the period in question a considerable proportion of Continental, Cannel, and stock coal was carbonized. The report on the subject was as follows: "Steaming was tried in No. 3 retort house during the last two hours of the charge. There appeared to be some improvement in the make of gas per ton (and there was a slight increase in the percentage of CO), but accompanied by a corresponding decrease in calorific value, so that there was practically no increase in the total therms per ton." It is reported that flexible hose connections were fitted to the mouthpieces for the introduction of the steam over the charge. A system of special hollow tiles through which the steam was passed, recessed into the bottom of the retorts, was tried in another retort house, but these were apt to break under the weight of the discharger ram. It is also of interest to note that the report further stated that: "German gas engineers appear to have come to the conclusion that steaming of retorts is not a profitable method of making water gas, and there is now a general consensus of opinion that water gas should be made in special water gas generators."

It has recently been realized that a new technique is required if the full potentialities of this process are to be fulfilled, and, following the interesting and valuable investigations undertaken and published by the Fuel Research Board, others have been prompted to explore its possibilities.

At the outset the author would like to make it clear that our own expectations have not yet been fully realized, nor has anything approaching finality been reached in the experiment—we are, in fact, at the present time at the most promising stage in the investigations, and we hope further to improve our results in the near future. That we have been longer than we would have wished in arriving at the present state of affairs is partly attributable to certain misfortunes and delays, due to circumstances over which we had no control. It will also be appreciated that in dealing with a unit as large as the one in question, it is a considerably more lengthy and expensive procedure to make alterations than in the case of a small one, and more time and attention are necessary for the maintenance of stable conditions under varying circumstances.

The whole problem has proved itself distinctly more complex than was anticipated, and certain aspects have arisen, calling for solution, which have emphasized the fact that much remains to be learnt regarding the reactions which occur during the steaming period, and concerning conditions which are conducive to a high steam percentage decomposition figure. At the same time it is to be hoped that members will not interpret these notes as a somewhat pessimistic review of the difficulties which have had to be overcome, and calculated to act as a deterrent, but rather as a submission of experiences and conclusions arrived at under our own particular conditions, which will serve to indicate some of the factors to be considered by those contemplating the adoption of the process. One might suggest that at some works there is, fortuitously, a particular combination of circumstances which will contribute to a high measure of success. There will probably be some who will not agree with certain of the findings and conclusions expressed herein, but any subject which is not provocative is unworthy of discussion.

Although the writer has not been associated with the work carried out at our Staines Manufacturing Station, he felt that a summary of the conditions and results obtained there, kindly supplied by Mr. J. Neath, the Engineer, would be of value if included in this Paper by way of contrast.

There are three main phases which cover the survey of the work so far carried out at Beckton:

(1) The preliminary trial, followed by the 12 weeks' test with half the house steaming, the other half being shut down. December, 1933, to August, 1934.
(2) The period following this test until No. 2 Section was also put on steaming (June-July, 1935) with half the house steaming and half on straight coal gas.
(3) From shortly after No. 2 Section also commenced steaming up to the present time.

Size of Charge.

It soon became evident that very little steam was reaching the further end of the retorts; this was due to the fact that the charges were too full for the purpose, and was made apparent by excessive pressure at the steaming end lids, and as a consequence the steam was no doubt breaking through the anti-dip seal into the hydraulic main. With a view to confirming this by concrete evidence some temperatures were taken by thermo-couple in the gas stream in the Bournemouth arch pipe at both ends of the retort simultaneously, both before and during the steaming period. From the fact that temperatures did not increase in the unsealed pipe after the admission of steam, it was found that in only one case out of 15 tested was an appreciable quantity of steam reaching the further end of the charge. We regarded this as the establishment of our first important principle. I should like here to stress a confirmation of this finding afforded by previous experience, when a number of pressure readings were taken by Arkon recorder from various mouthpieces in this house when working under normal conditions. That is to say, charges were not deliberately lightened sufficiently to ensure a constant gas-way over the whole length of charge, but they were not stuffed. The weight per charge during the period varied from 14·15 to 14·68 cwt., giving an average percentage full of 66·8, as against about 62·5 under steaming conditions. One of the dip pipes was plugged, and the readings revealed that in 60 cases out of a total of 76 a pressure of 1 in. w.g. was exceeded, and that in most of them this increased to something over 8 in. (well over the limit of the chart scale) until or unless a gasway was probed over the charge. This means that unless special precautions are taken to ensure a free space over the charge, a seal of over 8 in. would probably be required in order to make reasonably certain that most of the steam went up the further pipe; even so, there would be an excessive loss by leakage through the retort brickwork. Incidentally this illustrates one of the chief disadvantages of the single pipe retort where a high rate of throughput is desired, unless a type of charging machine is available which automatically lays a regular charge of coal. I would mention that the projector belt type of charger was instituted at Beckton as being most capable of giving the desired rate of throughput, and that a machine which is most suitable for steaming conditions would not give the requisite percentage full in the retort under normal conditions. Also the pressure which may arise due to a full charge, and which is so detrimental to steaming conditions with one ascension pipe only in action, is far smaller and of less consequence where two pipes are available.

The statement has been made in a report issued by the Fuel Research Board that "contrary to expectations no precautions appear necessary to ensure that the steam passes through the coke in the retort." Surely this requires qualification. Does not the crux of the matter lie in the fact that the Fuel Research Station have a Guest-Gibbons type of machine, which lays an even charge with a gas-way, whereas in our case and that of the other works in whose conditions and results I have been interested, the projector belt type machine is in use, and this relies on the human element? In addition, this evidence that steam will virtually not travel along the length of the retort unless there is a gasway, combined with general observations, would indicate that penetration into the coke is very slight and almost entirely along the crown of the charge—reference is made later on to the contention that retort

carbon is responsible for an appreciable percentage of the steam decomposition.

Damage Due to Wet Steam.

By March 8, 1934, the whole of No. 1 Section had been fitted with the quick-acting plug type of cock, and by the middle of June about 75 of them had become leaky through scoring and were replaced by 20 new ones, the remainder being reconditioned. The provision of the more highly superheated steam from the main in the retort house in May, 1935, put a stop to further trouble on this account.

An examination made towards the end of April revealed the fact that 46 mouthpieces were cracked in No. 1 Section, 38 of these being on the steam admission side. There is little doubt that most of them were caused by the steam condensate.

By this time also a number of bottom tiles at the same end of the retort had been replaced in Nos. 1 and 15 settings (where, it will be remembered, the condensate trouble had been most noticeable). The repairs in these two settings were out of all proportion to the rest of the house, and as no further abnormal mending has since occurred in either section, the natural conclusion is that wet steam was responsible.

There is therefore strong circumstantial evidence that saturated steam, in addition to the fact that it will not decompose in reasonable quantities, is directly culpable for damage to retort brickwork and fittings and the steam cocks.

Results on the 12-Hour Carbonizing Duration with 3 Hours' Steaming.

The steam pressures were balanced to give the same input to both sections, being 33 and 55 lb. per sq.in. respectively. No. 2 Section was the higher on account of the back pressure thrown by the sprays.

Steam admitted was 11·2% by weight of coal carbonized and decomposition efficiency 27·6%, average increase in CO 4·04%.

Total therms per ton resulting 81·7, the theoretical increase due to steaming was 6·78, while the actual increase over the average for other retort houses on the works was 7·2.

Weight per charge, 13·51 cwt. or 62·5% full.
Average calorific value, 480·6 B.Th.U.

This last figure is perhaps open to criticism on the grounds that the vacuum was kept rather higher than it might otherwise have been on account of the known leaky state of the retorts. Our object was to obtain the greatest economical input of steam and therms per ton resulting, and therefore to obviate as far as possible any leakage loss due to pressure in the retort. Further information will be sought as soon as convenient with varying conditions of vacuum. A recorder at one of the mouthpieces during the 12-hour duration test showed generally between level gauge and ¼ tenth w.g. vacuum.

Coke and Breeze.

The several tests made which have been carried out with the greatest possible care have shown a close agreement with one another; I consider them a fair indication of the loss due to steaming and one which would be expected, and is, in fact, comparable with that experienced in other systems of carbonizing where steaming is practised.

The total coke and breeze made for sale was 11·42 cwt. and the extra fuel consumption above normal probably over 0·22 cwt. and something under 0·62 cwt. per ton of coal carbonized. In view of the importance of these figures, the doubt that seems to be prevalent concerning them and the difficulty of obtaining an accurate estimate, I would like to enlarge on this aspect.

The coke made for sale was carefully checked and compared with that from a similar house working normally, having also a flume conveyor, so that the moisture content would be as nearly as possible the same; it was corrected in both cases to the same moisture figure. The last-named is rather less than in the case of the other types of coke handling plant in the retort houses consisting of drag bar conveyors and hand operated sprays. The moisture in the flume conveyor coke is also less susceptible to variation. The comparative made for sale figure was 12·1 cwt., which agrees closely with the works average, so that the loss in the case of No. 1 House would appear to be 0·68 cwt. or 76 lb. per ton of coal carbonized; this, together with the retort carbon consumed, has to account for carbon lost in the reaction with steam and any increase in fuel consumption. Since the theoretical quantity of carbon required by the steam decomposed is 37·5 lb. per ton of coal carbonized (or 43·5 lb. of coke allowing 16% for ash, moisture, and volatile content) this leaves the difference of 32·5 lb. of coke *plus* retort carbon consumed to account for increase in fuel consumption; it is unfortunately not possible to gauge the rate of scurf formation with any degree of accuracy.

As regards the actual increase in fuel used, I should not care to commit myself to a figure within close limitations. In order to arrive at the fuel fed to fires it is necessary to know the percentage yield of coke per ton of coal carbonized and the relationship between the weight of coal as charged to the top two "fire rows" and the average of all rows in the setting. This in previous experiments was found to be 93%. The only satisfactory method of finding the percentage yield of coke is to weigh a number of individual charges, pushed out and quenched by hand—and this introduces further possibilities of error due to varying moisture content, &c. However, this has also been done on previous occasions and found to be 69%. In the two calculations which have been made respecting the test in question it was assumed—

(*a*) that the above relationships held,

(*b*) that the weight of coal was the same in each row of retorts, due to lightening of the charge necessitated by steaming.

The resulting figures are probably the most optimistic and pessimistic. The fuel consumptions calculated on these lines, then, amount to 2·99 and 3·99 cwt. per ton, showing an increase over normal of 0·22 and 0·62 cwt. respectively; these figures are about equivalent to 4½ and 12½ tons per day. It would in any case be expected that the 12-hour duration would cause a greater consumption than the normal 10-hour period.

The 10-Hour Duration with Two Hours' Steaming.

It was evident that under these conditions the same rate of steam input would not give anything like the same percentage decomposition as the 12-hour period. Owing to the extra heat being extracted from the setting some difficulty was at first experienced in raising the heats to the desired extent. A full ½-tenth in. w.g. extra pull was worked on the waste heat boiler fan, and some extra attention was found necessary with regard to the fire cleaning. Owing to the fact that the clinker resulting from the cleaning was pulled out of the ash pan at the time and not left until the next cleaning (*i.e.*, for 8 hours) as is the normal practice, the decrease in coke made for sale quoted at 0·6 cwt. per ton of coal carbonized may be slightly greater than would otherwise have been the case.

The rates of steaming were varied temporarily, also the duration to 1 and 1½ hours without showing the desired difference in the analyses. The economic limit is probably nearer 7 to 8% under these conditions.

The increase in fuel consumption was 0·04 to 0·41 cwt. per ton of coal; it is less than for the 12-hour duration largely because the percentage decomposition of the steam was only about 60% of that on the former test. Therms/ton, 79·39; theoretical increase due to steam, 3·87. Weight/charge, 13·3 cwt. = 61·8% full. C.V., 504·7 B.Th.U.; make/ton 15,730 cu.ft.

SUMMARY AND GENERAL REMARKS.

The following are conclusions resulting from our own experience, together with some general remarks on the economic aspect of the process.

Retort House Procedure.

The type of charging machine is of extreme importance and of all the retort house plant probably has the greatest influence on the conditions favourable to good results. An automatic machine of the required capacity will lay the fullest possible charge consistent with an even gas-way, thus minimizing any tendency towards over-cracking of the gas, and will obviate the necessity for lightening the charge and thereby decreasing the throughput below normal. Charges themselves should be tapered at the charging end and should be far enough away from the mouthpiece to ensure a complete burn-off before steaming is commenced. In addition, it is desirable to maintain the combustion chamber temperature a few degrees higher on the same side of the bench in order to encourage the earliest possible decomposition of the steam.

Anti-dips should be of the most positive type and capable of withstanding, say, 6 in. w.g. without leaking; the seal should be as heavy as possible consistent with economic working conditions.

Combustion chamber temperatures will have to be raised unless the carbonizing duration is increased, because it is necessary to have a fairly complete burn-off by the time that steam is introduced. Retort surface temperatures

will probably vary between the bottom and top retorts from 1,000° to 1,100° C. at the time of discharge.

Scurf plays an important part in reacting with the steam and is instrumental in saving a further loss of coke. In addition, it is of value in preserving the state of tightness of the retorts and seals the pores as well as the joints in the brickwork. It will probably be most efficacious at least to double if not treble the normal period between scurfings.

The steam itself should be superheated and the pipeline, services, &c., lagged as far as possible. Wet steam will not decompose at all efficiently and is detrimental to retort brickwork, fittings, and steam cocks. At the same time it is realized that good results are apparently being obtained elsewhere with saturated steam, and this seems to be an important point requiring elucidation. I note in the publication of their steaming experiences by the Technical Staff of the Cardiff Gas Company[1] that "it was realized at the commencement that any success to be obtained as a result of our investigations could only be achieved by the use of as high a temperature steam as possible" and steps were taken to superheat it. Incidentally may I draw attention to the significance of the title of this Cardiff Paper, which was "Steaming of the Free Space in Horizontal Retorts," because it seems to me to epitomize the essential principle of the process. The layout of the services, &c., should be as simple and short as possible and of ample dimensions. Cocks are necessary to every retort to prevent steam service blockages; they should be easy of manipulation. High steam pressures are an unnecessary strain on joints, &c, and conducive to leakage. Steam measurement is highly desirable if the control necessary for the highest efficiency is to be expected. Meters are by no means infallible as to accuracy, but they should be designed for the job and certain precautions regarding their position of fixing and occasional maintenance inspection should be observed.

Retorts should be kept as tight as possible and conditions of pressure avoided. The amount of vacuum worked will depend on the calorific value required and on the rate of steaming. Steam helps to prevent the ingress of furnace gases during the burnt-off period, but if it is material in protecting the gas from overcracking, it cannot be to any great extent since practically all volatile matter has been evolved by the time steaming commences. The question arises as to where is the economic dividing line between loss due to overcracking and gain from the steam decomposition under conditions which must necessarily be conducive to both, for the gas analyses show a diminution below normal in methane and unsaturated hydrocarbons.

Complete gas analyses on the outlet of the house are essential for the evaluation of the steam decomposition efficiency. The CO_2 content, if excessive, will indicate over-steaming and observation of the inerts and cracking efficiency are necessary for the stabilizing of favourable conditions. Probably the best decomposition to be expected with a fairly heavy input—say, over 10% by weight of coal—is to be found in the case of intermittent vertical chamber ovens which attain an efficiency between 60 and 70%.

The quality of coal carbonized has an unquestionable influence on the steaming efficiency and wide variations in performance have been noticed in our own case, signifying that the rate of steam admission must be altered to get the best results from each type. No specific information is available from Beckton, but 16 separate consignments have been tested at Staines for periods of one week, and these exemplify the generalization that the first-class gas-making coals give the greatest increase in thermal yield when steamed. A chart which illustrates this point is given; the figures shown should not be taken too literally, as conditions were not continuously stable throughout the tests and steaming efficiency has improved since the period in question.

Some work was carried out by the Company's Chemical Research Staff at Fulham in an experimental plant from which it was found that the coke produced by one of the better class of gasmaking coals was definitely more reactive to steam than others; also that different qualities of coal require variations in the quantity of steam admitted for the best results. With 2½ hours' steaming commencing at the 9th hour the quantity varied from 7½ to 10% steam on the weight of coal carbonized.

Relative Performance on 10 and 12 Hour Durations.

No doubt the results would be improved by selected coals.

On the 12-hour duration 11·2% of steam by weight of coal was admitted during the last 3 hours; the decomposition was 27·6%. Therms per ton, 81·7.

[1] Wales and Monmouthshire Association at Cardiff, May 17, 1934.

On the 10-hour duration 11·3% of steam was admitted during the last 2 hours with a resulting decomposition efficiency of 16·3%. Therms per ton, 79·39. With further experiment these latter figures should be improved by varying the temperatures and rates and duration of steaming. On the other hand, it should be remembered that an increase as large or larger is probably easier to obtain when the initial standard is lower than in our case.

Coke and Breeze Made for Sale.

Works' Average.	Comparative House.	Steaming House.	
		10-Hour Duration.	12 Hour Duration.
12·2 cwt.	12·10 cwt.	11·50 cwt.	11·42 cwt.

COSTS.

Cost per therm of unpurified coal gas on normal 10-hour duration, allowing 3 gallons per ton of coal for benzole stripping . . . . . = 1·06d.

On the 12-hour duration with 3 hours' steaming . . . = 1·36d.

(No alteration was made in R.H. labour, though this would probably be arranged for extended period of working.)

On the 10-hour duration with 2 hours' steaming . . . = 1·35d.

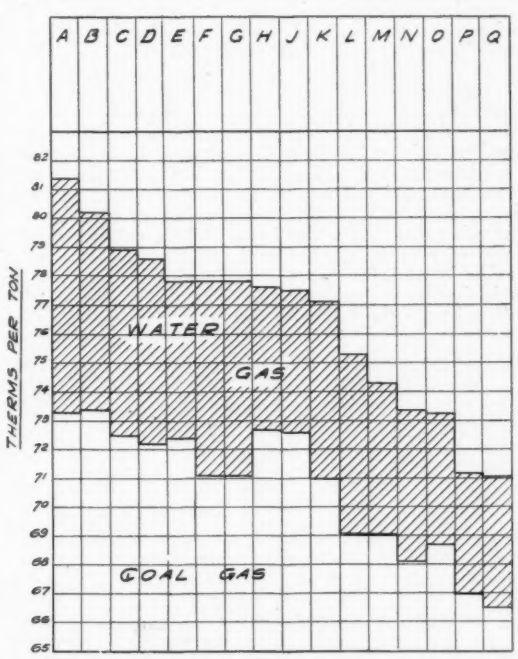
It must be remembered that in our case there is over 6% loss in throughput due to steaming, but in certain instances this would not be so and the cost per therm would then be proportionately cheapened.

Effect of Steaming on Purification.

The temperature of the gas at inlet to condensers is raised by about 10° C. due to steaming (extra water cooling has been provided).

Unconverted steam has reduced the liquor total strength at the condenser seal pot from 7·2 to 4·4 oz.

Thirteen 1-day samples taken at inlet to purifiers showed



Comparative Steaming Efficiencies of Various Coals Tested at Staines Works.

that the average H_2S content varied considerably, due to differences in coal and was sometimes considerably lower than the normal figure, so that only the average from a number of tests can be taken as any indication. The grains of H_2S per 100 cu.ft. were somewhat higher than normal in the steamed gas.

The benzole content in the steamed gas shown by several tests was 2·28 gallons per 10,000 cu.ft., and on normal coal gas at inlet to the activated carbon plant 2·58; the former figure reduced to a common basis per ton of coal carbonized becomes 2·52 gallons, so that there is not much difference. This is to be expected since steaming is not introduced until all or practically all gas has been evolved and should therefore have no appreciable effect on the benzole content.

Free carbon in tar for a period overlapping both durations was 20·7% against 17 to 18% normal average for the same period.

As the penetration of steam into coke is extremely slight,

it would not be expected that its combustibility or shatter index would be appreciably affected.

Economic Considerations.

It is noteworthy that in 1934 the Gas Industry in Great Britain used 129,000 tons less coke and 423,000 tons more coal than in 1933, the former being responsible for 6,626 million cu.ft. of water gas. Apart from any conversions from non-steaming to steaming carbonizing units, this means that generating plant, most of which is presumably fit for further service and capable of producing this quantity of water gas, is now proportionately idle, and that the balance (ignoring any actual increase in total works output) has had to be made up by the carbonizing of coal. Further, steps will have had to be taken to dilute the gas so made to an extent which would bring the calorific value down to that previously worked on the water gas plant.

In England and Wales there are 170 undertakings supplying gas under 500 but over 460 B.Th.U., and 276 at or under 460 B.Th.U.; of the former 121 have horizontal retort installations, of which 98 have horizontals only, while of those in the latter denomination 175 have horizontals, of which 144 have no other type of carbonizing plant. I do not know what proportion of these are stop-ended retort installations, but there is, on the face of it, no reason why these also might not be steamed if conditions were favourable; but probably insufficient heat for the process would be the stumbling block in the majority of cases.

It is suggested that a proportion of this substitution of coal for the coke consumed in gasmaking might with advantage be displaced in the case of works suitably disposed, by steaming of the horizontal retorts. Dilution would be somewhat greater than in the water gas generators (owing to some enrichment by oil in the case of the latter); but distribution costs will obviously benefit by the addition of water gas rather than inert gases as a diluent.

General economic considerations must, of course, depend to a large extent on local conditions—the demand for and value of coke, combined with the possession or otherwise of a water gas plant, the presence of a benzole washing unit, the margin, if any, of maximum make over peak demand, &c. It would therefore be foolhardy to dogmatize on the subject, but it may be of interest to expound a few general principles in given circumstances, and to compare the merits of steaming in horizontals with other expedients on the assumption that Beckton results are taken as a basis.

The advantages of steaming will be most in evidence in the case of a works where no other gas manufacturing plant is available, and dilution with inert gases is the only means of reducing the calorific value. The yields will be affected by steaming in the following way:

—	Gain in Cu.Ft./Ton.	Therms, Daily Make.	Drop in C.V.	Gain in Therms/ Ton.	Loss of Coke and Breeze for Sale.
		%	B.Th.U.		Cwt./Ton.
On 12-hr. duration.	2,770	−11·3	50	7	0·68
On 10-hr. duration.	1,500	− 1·3	25	4	0·60
	(2) 2,130	− 1·9	43	5	0·62

Steaming is bound to involve a decrease in throughput owing to the extra heat required per ton of coal; either the duration must be increased to obtain the requisite steam input and decomposition, or the heats have to be raised to an extent where the extra coal which would thereby be carbonized would give a make of gas in excess of that due to the steam.

Where a water gas plant is available, its discontinuation in favour of the retort house method will obviously involve a loss on capital and depreciation of plant, &c., depending on age and size, although its continued value as an auxiliary in time of peak demand must not be overlooked.

Benzole Washing.

F. B. Richards in his "Perspective in Carbonizing Costs"[2] draws attention to the effect benzole washing may have on the thermal yield per ton of coal carbonized, especially at lower calorific values, and points out that the latter are dependent, particularly with steamed vertical retorts, on the presence of "enrichers." He aptly sums up the question in general terms by stating that "benzole recovery can best be applied to the slimming of a fat therm, and is of little value in the case of a lean therm."

There are, however, a number of highly important points to be taken into consideration when the advisability of instituting benzole washing is under discussion—and here again it would be ill-advised to particularize. The general economic principles underlying the extraction process were comprehensively discussed by H. Hollings in a Paper presented to the second World Power Conference, 1930,[3] and considerations affecting the relationship between the coal gas and water gas manufactured, and the coal and oil purchased and coke made for sale when stripping for benzole is introduced, is discussed in the Paper by H. Hollings and S. Hay on the Recovery of Benzole by Active Carbon.[4] One of the principal points at issue is the replacement value of the therms lost by stripping, or in other words the manufacturing cost of gas into holder; when this is reasonably cheap the balance is likely to be in favour of benzole recovery. It is not proposed to publish any comparative process cost figures between benzole washing and steaming, but to present the subject in general terms and leave members to strike a balance by supplying figures applicable to their particular case. Nor is it desirable in a contribution of this nature to confuse the issue by citing every aspect and contingency likely to arise, but rather to examine the question only from the point of view as to how the two systems will compare as a means of reducing calorific value. In so doing, I would suggest that it should not be assumed that, because steaming is being practised, benzole washing may not also be adopted with advantage in given circumstances. For instance, a coal gas of 540 B.Th.U. quality can be steamed down to 500, and then further stripped to give a works outlet C.V. of 470 or 460 B.Th.U., the extra therms resulting from the steaming more than compensating for those lost by stripping, though at a lower calorific value; also the former process will be instrumental in increasing the profit from the sale of spirit, which in the first instance must include the cost of replacing therms so lost.

The capital cost of a benzole plant is considerably greater for a given carbonizing capacity than the corresponding steaming apparatus. But the net revenue from the sale

[2] Before the Eastern Counties Association, London, Oct 15, 1934.

[3] Economics of Benzole Extraction from Coal Gas. Trans. World Power Conference, 1930, **2**, 63.

[4] Before the London Section and the Chemical Engineering Group of the Society, London, Feb. 5, 1934.

Summary of Results. No. 1 Section, May 18—Aug. 10, 1934.

Date.	Make per Ton.	C.V.	Therms/ Ton.	Other Retort Houses, Therms/ Ton.	Increase in Therms/ Ton.	Increase in CO.	Weight per Charge.	Remarks.
Week ending—								
May 25 . .	14,371	529	75·19	73·85	1·34	2·03	13·77	) 10-hour work, 3 hours steaming, steam pres-
June 1 . .	14,771	525	77·51	71·65	2·89	2·48	13·10	) sure 40 lb./sq.in., ¾ in. diam. nozzle
,, 8 . .	15,358	492	75·50	73·67	1·83	5·09	13·20	12-hour work, two shifts for remainder of test
,, 15 . .	15,505	492	76·14	74·32	1·82	4·69	13·14	2-hour steaming commenced on June 12
,, 22 . .	15,860	480	76·08	73·65	2·43	3·61	13·07	3-hour steaming commenced on June 20
,, 29 . .	14,646	512	75·00	73·87	1·13	2·59	13·62	
July 6 . .	15,487	517	80·08	74·07	6·01	1·76	12·86	2-hour steaming commenced on July 1
,, 13 . .	15,986	488	78·05	74·17	3·88	4·23	13·17	
,, 20 . .	15,785	486	76·74	71·58	5·16	3·20	13·02	
,, 27 . .	14,840	505	74·69	71·75	2·94	3·02	13·22	
Aug. 3 . .	15,420	510	78·50	73·57	4·93	2·76	12·56	
,, 10 . .	14,830	511	75·72	74·24	1·48	2·57	13·27	
True average .	15,212		76·65	73·63	3·02	3·17	13·17	Total coal carbonized during test, 16,349 tons Total gas made, 248,613 000 cu.ft.

Average yield for the 5 months prior to the commencement of steaming = 72·22 therms/ton
Gain due to steaming . . . . . = 4·43 ,,
Gain over the average for the remaining retort houses on the works . = 3·02 ,,

No. 1 House, Results from Dec. 14, 1934, to Date.

Date.	Make per Ton.	C.V.	Therms/ Ton.	Other Retort Houses, Therms/ Ton.	Increase in Therms/ Ton.	Increase in CO. Whole House.	Weight/ Charge.	H.E.V.	Remarks.
Dec. 14–Jan. 3	14,505	509·2	73·83	75·5	−1·77	0·39	13·39	34·1	Half house steaming: 10-hour duration with 2 hours steaming. Commencement of fitting C.I. plug cocks in No. 1 Section
Jan. 4–Jan. 17	14,496	508·3	73·73	74·76	−1·03	0·36	13·43	34·0	
Jan. 18–Jan. 31	14,347	533·9	76·61	75·34	1·27	1·08	13·66	36·3	Fitting up of No. 2 Section commenced on Jan. 28
Feb. 1–Feb. 14	14,496	531·0	76·81	75·51	1·30	1·17	13·55	36·2	
Feb. 14–Feb. 28	14,257	536·6	76·38	75·81	0·57	0·04	13·75	36·2	
March	14,679	526·4	77·23	75·49	1·74	1·17	13·56	37·14	Completion of fitting plug cocks to No. 2 Section, March 8
April	14,800	527·5	78·04	73·65	4·39	0·80	13·79	37·56	By April 28 damage to mouthpieces and retort tiles found in No. 1 Section
May	14,870	524·1	77·94	74·96	2·98	1·13	13·61	36·90	May 4 drier steam; new connection to No. 1 Section
June	14,880	527·4	78·49	73·16	5·33	1·05	13·45	37·35	June 19, first Setting in No. 2 Section put on steaming
July	15,015	518·5	78·12	74·77	3·35	1·02	13·44	36·5	July 29, whole of No. 2 Section steaming; July 19–24, $\frac{7}{16}$ in. orifices fitted to top 3 rows of No. 2 Section
August	15,990	505·5	80·88	74·13	6·75	2·13	13·31	37·2	4th–18th, house down for 14 shifts; on 23rd, 12-hour duration with 3-hour steaming commenced
									Thereafter $\frac{5}{16}$ in. orifices fitted to remainder of the house and steam meters altered. Followed by—
12-hour duration	17 000	480·6	81·70	74·50	7·2	4·04	13·51	35·5	3 hours steaming, combustion chamber temp. 1,359° C.
10-hour duration	15,730	504·7	79·39	75·07	4·32	2·29	13·33	36·6	2 hours steaming, combustion chamber temp. 1,371° C.
(2)	16,364	487·3	79·72	74·82	4·9	2·49	13·16	35·1	2 hours steaming, combustion chamber temp. 1,382° C.

Results of Test Periods.

—	12-Hour Period Test.	10-Hour Period Test.	Normal Coal Gas.
Gas made, cu.ft.	95,28·,000	100,957,000	
,, per day, cu.ft.	6,592,000	7,211,000	7,043,000
Calorific value, B.Th.U.	480·6	504·7 (2) 487·3	
Therms made	457,971	509,509	
,, per day	32,712	36,393 (2) 36,160	36,877
Coal carbonized	5,605	6,418	
Gas made per ton of coal, cu.ft.	17,000	15,730 (2) 16,364	14,230
Therms made per ton of coal	81·7	79·39 (2) 79·72	
Weight per charge in cwt.	13·51	13·33 (2) 13·16	
Percentage full of retort	62·5	61·8	
Therms made per retort per day	109	121·3 (2) 120·5	
Percentage of steam used per ton of coal	11·2	11·3 (2) 9·2	
Percentage conversion of steam	27·6	16·3 (2) 22·9	
Gas analysis—		(2)	
CO_2	2·82	2·44 2·50	1·47
O_2	0·78	0·75 0·54	0·74
C_nH_m	2·27	2·31 2·31	3·22
CO	10·54	8·79 8·99	6·50
H_2	48·03	48·68 48·62	50·74
CH_4	24·53	25·86 25·77	27·78
N_2	11·03	11·17 11·27	9·55
Theoretical lb of C required for extra CO and CO_2	37·5	21·5 (2) 2,·1	
Increased therms due to water gas per ton coal	6·78	3·87 (2) 5·1	
Coke and breeze made for sale, cwt./ton	11·42	11·50 (2) 11·48	In normal house over same period 12·1
Combustion chamber temperatures	1,359° C.	1,371° C. (2) 1,382° C.	
Surface temperature of retorts at discharge	1,010 1,100° C.	1,010–1,100° C. (2) 1,020–1,120° C.	
Surface temperatures of retorts before steam	1,050–1,100° C.	1,000–1,060° C. (2) 1,020–1,090° C.	

Net Cost per Therm of Gas Manufactured in the Retort House.

Normal Carbonizing.

10-hour work all retorts, no steaming.
14·4 cwt. per charge—688 charges per day.
Coal carbonized per day, 495 tons.

Yield—

Therms made per ton	70·3
Therms made per day	34,798
Coke made for sale, 10 cwt./ton	247 tons
Breeze ,, ,, 2¼ ,,	56 ,,
Tar ,, ,, 10 gall./ton	4,950 gall.
Benzole ,, ,, 3 ,,	1,485 ,,
Coal carbonized per day	£489·02
Less return for residuals	370·61
Net coal	£118·41
Labour	36·00
Cost per therm of unpurified gas	1·06d

Test Period 12-Hour Work Results.

12-hour carbonizing period, 3-hour steaming.
13·51 cwt. per charge.
Coal carbonized per day, 400 tons.
Steam used per day, 44·8 ,,

Yield—

Therms made per ton of coal	81·7
Therms made per day	32,680
Coke made for sale, 9·32 cwt./ton	186 tons
Breeze ,, ,, 2·1 ,,	42 ,,
Tar ,, ,, 10 gall./ton	4,000 gall.
Coal carbonized per day	£395·47
Steam used per day	3·02
Less return for residuals	248·79
Net coal	£149·70
Labour	36·00
Cost per therm of unpurified gas	1·36d.

Test Period 10-Hour Work Results.

10-hour carbonizing period (bottom row 12-hour), 2-hour steaming.
13·33 cwt. per charge.
Coal carbonized per day, 458 tons.
Steam used per day, 51·7 ,,

Yield—

Therms made per ton of coal	79·39
Therms made per day	36,393
Coke made for sale, 9·38 cwt./ton	214·5 tons
Breeze ,, ,, 2·12 ,,	48·5 ,,
Tar ,, ,, 10 gall./ton	4,580 gall.
Coal carbonized per day	£452·47
Steam used per day	3·51
Less return for residuals	286·57
Net coal	£169·41
Labour	36·00
Cost per therm of unpurified gas	1·35d.

For the above the yield of tar has been taken as 10 gallons per ton, as the quantities could not be checked. In some cases it may be possible to reduce labour when on 12-hour carbonizing duration.

No. 1 Retort House.—Comparisons With and Without Steaming of Retorts.

[Ammoniacal Liquor in Circulating Tanks.]

Date.	Before Steaming. NH_3.		Date.	After Steaming. NH_3.		Date.	After Steaming. NH_3.	
	Free (Oz.).	Total (Oz.).		Free (Oz.).	Total (Oz.).		Free (Oz.).	Total (Oz.).
1933.			1934.			1935.		
May 17–24 . .	..	..	May 16–23 . .	0·6	6·8	January . .	0·7	9·6
,, 24–31 . .	0·8	21·5	,, 23–30 . .	0·5	6·2	February . .	0·7	9·6
,, 31–June 7 .	..	..	,, 30–June 6 .	0·5	8·0	March . . .	0·7	10·5
June 7–14 . .	..	..	June 6–13 . .	0·5	6·6	April . . .	0·7	11·8
,, 14–21 . .	0·9	14·3	,, 13–20 . .	0·5	6·1	May . . .	0·7	12·2
,, 21–28 . .	1·0	11·8	,, 20–27 . .	0·6	7·7	June. . . .	0·6	13·8
,, 28–July 5 .	0·9	13·2	,, 27–July 4 .	0·5	7·0	July	0·4	19·2
July 5–11 . .	0·9	13·4	July 4–11 . .	0·7	6·7	August . . .	0·5	19·1
,, 12–19 . .	1·0	12·2	,, 11–18 . .	0·6	6·7	September .	0·5	14·7
						October . .	0·5	12·2

Comparisons are made during a similar period each year when the atmospheric temperature conditions are presumably similar; for 1935 the strengths are given to date.

Monthly Samples of Tar.

Date.	H_2O.	Free Carbon.	Ammonium Chloride.
	%	%	%
1933—June	5·3	7·4	1·7
1934—June	17·4	19·8	1·8
1935—October . . .	14·4	20·7	1·4

of benzole is the final profit, inasmuch as no further liabilities are incurred outside the works, whereas in the case of steaming, any variations in yield resulting will have a proportionate bearing on distribution costs, &c. In the case of a reasonably efficient stripping of, say, 2½ gallons per ton of coal carbonized, the loss, equivalent to about 1·5 therms per gallon is 3¾ therms, and in the case of a retort house working at 550 B.Th.U. the drop in volume and calorific value respectively would be of the order of 700 cu.ft. and 30 B.Th.U. per ton of coal. The ultimate manufacturing cost of the gas may be materially increased above normal where allowance has to be made for the loss of benzole due to steaming, so that the replacement cost would then be the deciding factor. Where a C.W.G. plant is available depreciation, &c., will have to be accounted against either process.

In short, where benzole stripping is out of the question, steaming of horizontals is likely to prove of benefit as a diluent and as a means of increasing the thermal yield per ton. It may also prove convenient as a substitute for a C.W.G. plant, but only where this is used as a means of reducing calorific value and not where it is considered as an auxiliary gas making plant.

In conclusion, if I have entered into somewhat close detail in certain matters, it is because I felt it desirable for the full appreciation of what practical value the Paper may have. The subject, which is most intriguing, is one of some consequence. It is much to be hoped, therefore, that those members who are in a position to do so will give the meeting the benefit of their views and experiences.

My thanks are due to those members of the staff to whom I am indebted for valuable assistance in obtaining the information recorded, to Mr. J. Neath for the particulars relating to Staines Works, and to the Directors and Chief Engineer of the Gas Light and Coke Company for permission to publish this Paper.

APPENDIX.

Steaming of the Horizontal Retort House at Staines.

The gas-making plant at the Staines Works of the Company consists of a retort house of fifteen beds of sixes, 18 ft. long, " D " section, 22 in. by 16 in., and a water gas plant of two sets, each capable of making 200,000 cu.ft. per day. The water gas plant had been shut down early in 1933 owing to the high cost of production and maintenance. The quality of the coal gas had been reduced to the declared calorific value by introducing producer gas into the foul main. Following the publication of the William Young Memorial Lecture by the Director of the Fuel Research Board in September, 1933, it was decided to apply the steaming process to the horizontal house.

The house was equipped with double ascension pipes and anti-dips having an internal seal. The normal carbonizing period was twelve hours and the combustion chamber temperatures averaged 1,330° C. Experiments to decide the new conditions and layout of steam piping were started in October, 1933. By the end of December, 1933, the whole house was fitted up and the results had shown progressive improvement. Combustion chamber temperatures had been raised to an average of 1,350°-1,360° C. The seal of the dips on the steam inlet side of the retorts was increased to 3 in. Very little superheated steam is available at Staines, and the steam services were lagged and an ample number of traps fitted. The scurfing period was increased from fourteen days to six weeks.

From January until July, 1934, tests were carried out on various consignments of coal and the results show that in general the better the coal for gas making, the better it is for steaming.

The results up to June, 1935, are shown in the following table in 6-monthly periods:

—	1933.		1934.		1935.
Half-year ending . .	June.	Dec.	June.	Dec.	June.
Steaming . . .	*Nil*	From September, 1933, working fully			
Make/ton . . .	13,585	14,732	15,365	15,587	15,881
C.V.	533·4	501·6	501·5	500·3	499·3
Therms/ton. . .	72·46	73·9	77·01	78·01	79·29
Gas analysis—					
N_2	11·7*	14·1*	9·4	8·8	8·7
CO_2	2·0	2·3	2·5	2·8	2·7
O_2	0·5	0·6	0·6	0·6	0·8
C_nH_m . . .	2·3	2·2	1·9	1·9	2·1
CO	6·4	8·2	10·2	10·4	10·4
Cu.ft./ton of CO_2 .	272	339	384	436	429
,, ,, CO .	869	1,208	1,567	1,620	1,651
Water gas, make/ton	..	1,098	1,951	2,213	2,254
Water gas, C.V. .	..	288	294	289	291
Water gas, therms/ton.	..	3·17	5·73	6·39	6·54
Coal gas, make/ton	13,585	13,634	13,414	13,374	13,627
Coal gas, C.V. . .	533·4	519	531	536	534
Coal gas, therms/ton.	72·46	70·73	71·28	71·62	72·75

* High inerts during these periods due to dilution with producer gas. This was gradually reduced from October onwards by steaming. The calculations for water gas make, &c., for December quarter, 1933, are also inaccurate for this reason.

Other points emerging from the work carried out at Staines are as follows:

There is some advantage to be gained by steaming at the discharge end, because the coke plug normally left in the mouthpiece at that end, when pushed back into the end of the retort brickwork, serves to heat the incoming steam. It was not practicable at Beckton to steam from the discharge end.

Medium weight charges give better steaming efficiency than heavier ones, owing to the greater free space and surface of coke exposed to the steam and the higher temperature resulting from the smaller amount of coal to be carbonized.

Discussion.

The PRESIDENT (Mr. E. L. Nicholas, of Guildford), in opening the discussion, remarked that when he had been looking round for a subject for discussion at this meeting it was suggested that steaming in horizontal retorts had become a matter of renewed interest. He wrote to Mr. Thomas Hardie, who with his usual courtesy, had said that he would be pleased to place any experiences of his Company in this connection at the disposal of the Association. They were deeply indebted to Mr. Hardie for allowing this Paper to be published and to Mr. Braidwood for reading it, as well as to the Gas Light and Coke Company for making their experiences available for discussion.

Turning to the Paper, Mr. Nicholas said that it would appear that if works had no dip pipes they could not carry on steaming, or were involved in the cost of fitting dip pipes in addition to the steam pipes. At Guildford they had fourteen settings of horizontal retorts with single Congdon standpipes. On such a plant he understood that they would have to do nothing else

but fit the steam pipes in order to carry out steaming. He would like to have Mr. Braidwood's opinion as to the desirability of commencing such practice, as they distributed 450 B.Th.U. gas, stripped 2¼ gallons of benzole, and manufactured 25% water gas, slightly carburetted. It was essential for them to manufacture water gas, as it was part of their plant; furthermore, it was an up-to-date plant, and they did not want to shut it down. Considering the effects of steaming, he was puzzled at the position of the gas undertaking which disposed of all its liquid products in crude form.

As regards costs, Mr. Braidwood gave these as identical in each case; but he wondered whether that could be the case when one considered that steam pipes required much attention—in fact, the whole Paper pointed to a great deal of labour being involved on both pipes and retorts, together with additional supervision generally. In conclusion, Mr. Nicholas said that the Paper had been a most valuable contribution, and he was sure they had not heard the last of the question of steaming.

Mr. R. W. Hunter (Chief Engineer, Gas Light and Coke Company) referred to the patient and careful work which Mr. Braidwood had put in. Mr. Hunter had been associated with the Beckton Station for many years, and he knew something about the early part of the work. He was quite sure that the details Mr. Braidwood had given would repay the work they had done in this connection. The matter of steaming in horizontal retorts was not a new one; it was practised many years ago. The earlier experiments at Beckton did not last very long; perhaps they were not taken very seriously. No attempt was made to supply dry steam; there was a reluctance to reduce the throughput of coal; there were limitations to the capacity of the producers, so that they could not increase the temperatures as they would have liked to do; and there was no provision for the measurement of the steam. The points dealt with in the Paper were valuable in any conclusions in regard to the process.

The President took the opportunity of expressing the Association's great pleasure at Mr. Hunter's recent promotion to the Chief Engineership of the Gas Light and Coke Company.

Experience at Colchester.

Mr. W. W. Townsend (Colchester) said that he had been steaming in a much smaller plant since the early part of the present year; but his experiences did not coincide with Mr. Braidwood's, the reason being that the conditions were different. Mr. Braidwood had very fairly pointed this out in his Paper; but it might be that some would turn to the conclusions and not bother about the details. Most, however, would turn to the cost per therm figure, and on finding it higher they would abandon the idea. The conditions at Beckton were not those ruling everywhere. It was hardly fair to the process to alter the period of carbonization from ten hours to twelve hours and debit the process with the full carbonizing wages appertaining to the previous conditions. The retorts which had been used were segmental and the machine was of the projector type. It was not retort settings with pipes at both ends that counted or anti-dip valves, for all he did was to fit steam pipes and increase the temperature to 1,400°—which compared with Mr. Braidwood's figure of 1,350° to 1,370°. In order to make quite sure that they were not gasifying scurf he had fitted up further beds of retorts immediately after repair, when they were quite gas tight, and on these they had the best results of all.

He did not agree with Mr. Braidwood's argument that some of the gas was made from retort carbon—in fact, he considered that one of the weaknesses of the process was that they did not get any retort carbon. They did not get any on the crown of the retort, though it formed at the bottom, and they had lengthened the period of scurfing from six weeks to three months. They had worked for years on twelve-hour carbonizing periods, with two shifts only, and they had not had any increased labour. A year ago they had been making 30% blue water gas, extracting 2 gallons of benzole per ton of coal, and sending out 480 B.Th.U. gas. This year, with the same plant, they were steaming to 5% of the weight, still extracting benzole, and were working the water gas plant to make 10% instead of 30%. One of the drawbacks of steaming was inflexibility. He did not go much above 5% in steaming; but if he could go to 11% he could shut down the water gas plant entirely. As there were no extra wages the costs were practically the same, while the results showed 106 therms per retort per day, the retorts being 23 ft. long by 24 in. by 16 in. They were making considerable saving in the increased coke they had for sale. It was absolutely necessary that the charge should be thoroughly burnt off before steaming was admitted. Mr. Townsend had had the temperature taken in the retort before steaming and the average was 1,040° at the top and 1,000° at the bottom. After two hours' steaming the temperature had increased 11° in the one case and 25° in the other, due to the input of heat from the settings. They were obtaining better results by steaming from both sides of the setting, and he had tried this on one bed by steaming for 1½ hours alternatively on each side. It was essential that the charge should be well back from the mouthpiece, so that it was thoroughly carbonized before the steam was admitted. They were getting about 5 therms per ton increased yield, but there was an extra quantity of fuel used, and Mr. Braidwood's estimate was a very close approximation.

He did not agree with Mr. Braidwood when he said that retorts were not so leaky with steaming. They depended upon the carbon to seal the cracks in the retorts, and he found that there was a tendency for retorts to become more leaky as steaming proceeded. This was one of the great drawbacks; another was that the higher temperatures might lead to greater wear and tear on the settings. He had also experienced increased trouble from stopped pipes. They were maintaining a temperature to get the highest efficiency, and if the charging was not done very well they would have the old bugbear of cracked pipes. He expected to find an increase in the sulphur compounds, but so far this had not been material. He had 20 grains of sulphur per 100 cu.ft. in the purified gas. All those who had horizontal retort systems would be well advised to give careful consideration to this matter—although it was not all profit. He was satisfied, however, that there was a decided advantage.

In conclusion, Mr. Townsend said that Mr. Braidwood had stated that where water gas plant was thrown out of use by the adoption of steaming one must consider the depreciation and capital costs of the water gas plant. But one had to pay such costs in any case; and if one shut down the water gas plant entirely one saved the heavy maintenance charges as well as the coke used in that plant. Where there was a good market for coke this was an important consideration.

Mr. L. J. Langford (Tunbridge Wells) added his appreciation of the Paper, and remarked that anyone contemplating steaming would find the information given in it most valuable. At Tunbridge Wells they had not yet gone very far, though they had adopted it on a bench of seven beds of 10 23-ft. by 24-in. by 18-in. retorts, and were feeling their way. They carbonized washed Durham nuts in 16-cwt. charges and used a three-sixteenths jet for steaming. The carbonizing period was twelve hours, steaming at 30 lb. The steaming period was one hour on the bottom retorts, one and a half hours on the second and third tiers, and three hours on the fourth and fifth. The chamber temperature was from 1,380° to 1,400°, and they worked at practically level gauge. They had to provide anti-dips, and the temperature in the retorts after discharge was from 980° to 1,080°. After a month's work on steaming they had increased their output by 560 therms per day. This had meant a large saving in water gas manufacture, and taking the month of October they had saved in wages on the water gas plant £27 1s. 10d. From this point of view steaming was going to pay them.

He realized all the difficulties which had been mentioned, but there were one or two they had not met with, particularly that of wet steam. They had not noticed any cracking of the mouthpieces nor any depreciation so far as the retorts were concerned. They left about 3 ft. of coke in the retort after discharging in the hope that it would assist in the steaming; but it did not. The propeller charger might have banged the coal up against the coke, and they had stopped this now. He considered that they should get a certain amount of the steam well into the coke, but this was practically impossible. It was only surface contact. Previously they were getting 70 therms and now they were getting 75—without any additional labour. He was glad to know, said Mr. Langford in conclusion, that they might still be optimistic of better results from the process.

Mr. W. Miller (Walton-on-Thames) stated that his undertaking had been steaming since February last with good results. Their charges were 13·3 cwt. and the temperature 1,380° one side and 1,360° on the machine side. They steamed at the discharge side. The results for the month of February were 76 therms per ton, while previously they had been just under 72. In March they got 78 therms, and from April to June 79·3 therms. During that period they investigated the possibilities of a shorter run, with the result that they obtained 89·2 therms per ton. They made a close analysis and found that the total percentage of inerts at 81 therms per ton was too high at over 13. At 78 therms they were brought down to 10·5%, leaving 7·4% of nitrogen. They were stripping at the rate of 2·5 gallons of benzole, so they concentrated on 525 B.Th.U. in the retort house, which gave a thermal yield of 78, and this was what they were producing to-day. This could be reduced still further with blue water gas, or slightly carburetted, to 495 B.Th.U., and they then stripped still further to 470 B.Th.U. by benzole washing

They had some difference in the coke field. Previous to steaming, the coke yield had been 13·63 cwt. per ton; since steaming it had been 13·33 cwt. per ton. The coke for sale had previously been 10·6 cwt. per ton, and now it was 10·2 cwt. The coke used in the producers had formerly been 3·03 cwt. per ton of coal carbonized, whereas it was now 3·13 cwt. In conclusion Mr. Miller gave details of the composition of the gas produced.

From a Chemical Engineering Viewpoint.

Mr. P. Parrish (South Metropolitan Gas Company) made a number of observations, from a chemical engineering viewpoint, Singularly few gas undertakings in this country, he said, had facilities, or could provide the expenditure involved in such a comprehensive investigation, as was represented by the results incorporated in the Author's contribution. Such extensive data called for careful examination—indeed, it was certain that they would be studied with interest, not only by the members of the various gas associations in Great Britain, but not less so by those associated with the Institution of Chemical Engineers, the Institute of Fuel, and other allied organizations.

The Paper compelled consideration of two significant questions: (*a*) Under what circumstances was one justified in steaming the incandescent carbonaceous substance in a horizontal retort, and (*b*) was there no other or better way by which the object so sought could be achieved?

It would be conceded that where standard coals were carbonized in horizontal retorts in good condition and under satisfactory control, coal gas having a C.V. of the order of 570 B.Th.U./cu.ft. could be manufactured. If the undertaking had declared a C.V. of 500 B.Th.U./cu.ft., or thereabouts, it was obviously necessary to adopt some method by which the high calorific value gas could be reduced to the declared value.

Under such circumstances, one appeared to be intuitively attracted to steaming, because of the feeling that advantage could be taken of the sensible heat of the incandescent substance in the production of water gas as a convenient diluent, at little or no expense. But a little reflection revealed that not only was a horizontal retort an unsatisfactory apparatus in which to generate water gas, but that it was illusory to suppose that the sensible heat of that portion of the incandescent carbonaceous substance to which the steam had access could decompose any appreciable quantity of such steam without the continuous input of heat from the producer. Clearly, the production of water gas involved (*a*) the maintenance of a specific temperature and (*b*) a certain time contact.

Chemical engineering science would deprecate the application of heat through the walls of a retort, and through the additional hot carbon substance, as an economical means of maintaining the desired temperature. Again, Mr. Braidwood had made it clear that if adequate time contact was to be obtained, light charges must be arranged, so that a greater free space was available above the incandescent carbon substance. One could scarcely justify light charges in an attempt to attain a better steam decomposition. Retort settings were far too expensive an equipment, as regards capital cost, to admit of a division of their use between coal carbonization and water gas production. The production of the cheapest therm obviously involved the best utilization of a retort setting for coal carbonization, and it was essential not only to determine what was the optimum duration for a given coal under given conditions, but clearly it was necessary to direct control to the maintenance of such optimum conditions.

The foregoing aspects appeared fundamental, from the viewpoint of chemical engineering. What light was shed by the investigations of Mr. Braidwood on these basic principles? Mr. Braidwood had repeatedly urged, in his Paper, that steaming did not commence, in his case, until carbonization had practically ceased. His figures revealed that with a 12-hour period, involving three hours' steaming, using every effort to maintain a suitable temperature for steam decomposition, the conversion efficiency was only 27·6%, and with a 10-hour period, involving two hours' steaming, the conversion efficiency was only 16·3%. Thus, in the first case, of the 250·9 lb. of steam admitted to the retorts, per ton of coal carbonized, no less than 183 lb. emerged undecomposed; and in the second case, of the 253 lb. of steam introduced to the retorts, no less than 212 lb. emerged undecomposed. Thus, the quantity of gas liquor per ton of coal carbonized was increased by 18·3 and 21·2 gallons respectively. Yet such results, which were surely gravely disappointing, involved the retort settings being out of action, as regards coal carbonization, for periods of three and two hours respectively, in 12 and 10 hour periods.

But this did not exhaust the catalogue of adverse results. The free carbon content of the tar was increased, the chemical works was called upon to distil between 47·2 and 44·3 gallons of gas liquor, against a normal 26 gallons of 12 oz. liquor—such gas liquor was inferior, not only in point of ammonia dilution, but it contained an appreciably higher content of CO_2 (thus involving a sensibly increased expense if concentrated gas liquor was to be manufactured), the volatile matter in the coke must be affected, and the ash content increased in proportion as carbon was used in the production of water gas.

Producer Gas Dilution.

Now it would appear that suitable dilution of the high calorific value gas could best be obtained by admixing producer gas—say, having a composition of

CO	28%
CO_2	6%
H_2	6 to 8%

after the scrubbers. This would appear to be the economic solution, and it would have the virtue that the volume and composition of the gas liquor would be identical with what was obtained under straight coal carbonization.

Fortunately, Mr. Braidwood was not content to leave the issue as expressed by the foregoing results, culled from his contribution. He provided pecuniary figures, representing the net cost per therm of gas manufactured in the retort house, under the conditions of (*a*) normal carbonizing, (*b*) test period of 12 hours' working, and (*c*) 10 hours' working. On the basis of these figures, the adoption of steaming in horizontal retorts undoubtedly stood condemned as peculiarly uneconomic, because the cost per therm of unpurified gas was increased from 1·06d. to 1·36d. and 1·35d. respectively.

Mr. Braidwood and his Company were to be congratulated, said Mr. Parrish, on the clarity and signal honesty with which they had presented the detailed figures arising from their investigation, and particularly on the provision of a financial statement, without which a true perspective would be impossible. It would be well if the Fuel Research Board would follow the example of Mr. Braidwood and his Company, and allow their technical results in future to be accompanied by a financial statement, in order that the implications of any parallel investigations might be adequately appreciated.

Capt. J. Fraser Shaw (Fuel Research Station) said that this was a very important Paper, and he thought the thanks of all were due to the Gas Light and Coke Company for publishing this account of the work which they had been doing at Beckton in applying experimental data to commercial practice on the larger scale. Mr. Braidwood was to be congratulated on the frank and straightforward way in which he had recounted the difficulties which he and his colleagues had met and had to a large extent overcome. There were now some round dozen of undertakings which were trying to a greater or less extent the effect of steaming horizontal retorts, and it was in no way in the spirit of criticism but in the hope of assisting these and the many others who were interested in the subject that he wished to put forward suggestions in connection with what had been done at Beckton.

When carried out successfully, steaming in horizontal retorts was probably as near an approach to getting something for nothing as was possible in the commercial world. Successful steaming in horizontal retorts should be to all intents and purposes a free gift of 1s. per ton of coal carbonized to the gas concerns which undertook it. Results which had been obtained at the Fuel Research Station were published in the Annual Report of 1934. It was there shown that they had obtained an increase of 10·3 therms by supplying 5·7% of steam by weight of coal spread over the last three hours (*i.e.*, 26 lb. per retort per hour) of a 12 hour period of carbonization. Since they received the proof of Mr. Braidwood's Paper they had tried to repeat his condition in an experiment, and and for the last three days they had obtained an increase of 13·0 therms by supplying 50 lb. of steam per retort per hour—that is to say, 10·7% by weight of the coal spread over the last three hours of a 12 hour carbonizing period. He would also mention that by supplying 62 lb. of steam per retort during the last hour of a 12 hour carbonizing period—that is to say 4·5% by weight of coal—they had obtained an increase of 6·1 therms per ton. In their experiments in this connection at the Fuel Research Station they had really made only one discovery—that it was not essential that the steam should travel through the bed of coke. The other points—namely, temperature required and the time of contact necessary were common knowledge to all through experience in making water gas in the orthodox plant. This was also brought out by Mr. Braidwood in his Paper so that they were all agreed on the point.

Since the results previously reported they had at the Station arranged that one of the retorts could be entirely isolated from the remainder of the setting so far as its yields were concerned. It had its own exhauster, condensing plant, and meters, and they were able to obtain samples from this retort during the whole period of steaming. It took their team of engineers, chemists, and retort operators more than six months to establish satisfactory conditions in this system, but they were now in a position to be able to say that the results definitely were reliable and repeatable. For the last three days they had therefore taken samples over every quarter of an hour for the whole period of the three hours steaming, and by means of an arrangement for condensing the water vapour collected in the gas they were able to state that the conversion during this period was:

Quarter Hour Periods.	*Quarter Hour Periods.*
67	50
65	45
54	52
57	53
50	49
53	54

being an average of 54% conversion for the whole period. The conversion in the other case quoted where steam was supplied for one hour was:

Quarter Hour Periods.	*Quarter Hour Periods.*
80	63
60	51

He therefore needed only to restate the physical fact that if a certain quantity of steam was in contact with coke for a sufficient length of time at a sufficiently high temperature, a certain conversion of steam to water gas must take place, and therefore there was no reason why the same results should not be obtained at Beckton and elsewhere as are obtained at the Fuel Research Station. Mr. Braidwood has shown them the very great difficulty that there was in maintaining a satisfactory steam supply to a large bench of retorts; but if it once got there—and he thought he was satisfied that it did do so—the same conversion ought to occur in the one setting of the retorts as in another if the conditions were the same. He would therefore like to suggest some possible reason why the same results were not being obtained at Beckton as at the Fuel Research Station. First, with regard to the space over the retort, they had a Guest-Gibbons charging machine, but they always packed the retorts towards the discharge end as fully as it would hold. The first shot was laid in the centre of the retort; the machine was withdrawn, and by means of the ram head of the machine the first shot was then pushed to within 6 in. of its final position. The second shot was then charged and pushed home so as to push the first shot 6 in. forward into its final position. This was then backed heavily by the third and fourth shot. In this way the further half of the retort from the charge end was largely filled as tightly as could be done by any other type of machine. They found that the shrinkage of the coke on carbonizing was sufficient to allow the volume of steam to pass over the top. Of course, if the steam were supplied to the retort before the shrinkage took place the steam could not possibly get through. It therefore seemed that it might be possible, by using steam at a higher rate for a shorter period at a later stage to obtain the same results as were being obtained at Beckton without reducing the weight of charge and throughput in the slightest and with a saving of a very large quantity of steam. For instance, the example quoted before approached very nearly to it. An increase of 6·1 therms for the application

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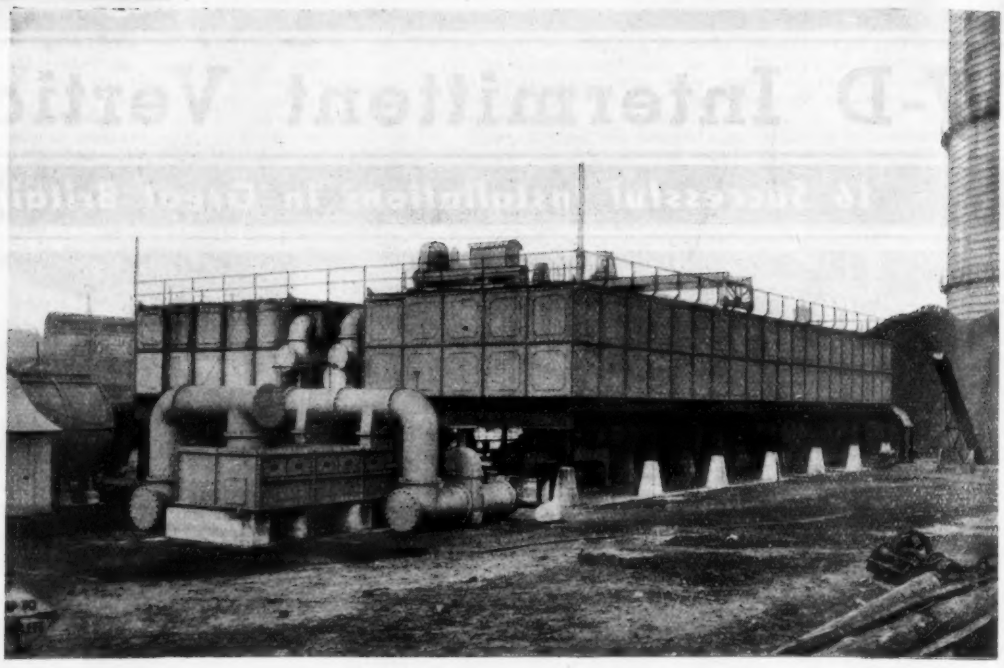

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Secondly, it was not sufficient to bring steam to the retort, but they must be quite certain that the whole of the steam passed over the charge. Mr. Braidwood was fully alive to this. He did not feel that the valve, as illustrated in the Paper, by any means made certain that this would be the case. If such a sleeve was loose enough to be operated under the conditions which obtained in an hydraulic main when no steam was used, he thought it was almost certain that when heavy tar was removed by the action of the steam, the sleeve would not prevent the discharge of the steam from the off-take into the main. This had actually been the experience of other engineers in similar circumstances. He therefore suggested that a portion of Mr. Braidwood's steam was escaping from his retorts without passing over the coke at all.

Thirdly, it must be remembered that by supplying large volumes of steam the time of contact was reduced to a minimum, and that it was quite probable that by using a small quantity of steam, as good results would be obtained and there would be a smaller drain of heat from the retorts. They were carrying out a very elaborate series of experiments on this particular point at the Fuel Research Station at the present moment.

Maintenance of Temperature.

Fourthly, it was essential for the conversion of steam in the very short time which it was in contact with the coke in passing from one end of the retort to the other that the temperatures should be maintained at between 1,000°-1,100° over practically the whole length of the retort. Mr. Braidwood apparently found a difficulty in obtaining these temperatures with the result that very much less of such steam as did pass from his retort was converted into water gas than would be the case were he able to obtain a temperature of, say, 50° higher than those stated in the Paper. Particularly was this the case in the lower tiers of retorts. The Beckton retorts were large and had very heavy charges, and presumably the producer was working in what was normally considered the most satisfactory way and the temperature in the combustion chamber was as high as practicable. It therefore seemed that the only way in which the temperature of the retorts could be increased without raising the combustion chamber temperature was by increasing the volume of gas which was passing round the retort. This might be done either by making poorer producer gas and thereby being compelled to use more of it, or by allowing the inlet of a greater quantity of secondary air than was actually necessary, and so reduce the CO_2 in the flue gases to, say, 15%, or by circulating flue gases through the producer and round the retort. It would appear from Mr. Braidwood's statements that so far from making poor producer gas he had attempted to make the very best producer gas and had thereby found it necessary to clinker more when steaming than when not steaming. He would suggest that if Mr. Braidwood made a poorer producer gas either by supplying more water to the grate, or, better still, by supplying a jet of steam to the under-side of the grate, he would then find that the increased volume of gases passing round the retorts would even up the temperature from the centre towards the ends, and he would obtain a higher temperature in all his retorts. Of course, any expenditure of coke which might or might not be measurable would be necessary to increase the temperature of the steam up to the temperature of the combustion chamber.

At the Fuel Research Station they had maintained a steady temperature of 1,350° in a combustion chamber with producer gas of a calorific value of 40 B.Th.U. and had benefited greatly by the increased heat supplied to the retort.

Mr. Braidwood recorded the difficulties he had had with regard to the entrance of the steam into the retort. He spoke of damage to the silica of which the retort was built. Capt. Shaw could only say that with their siliceous retorts they had had no such experience except that the continual cooling and re-heating of the end of the retort had in some cases given them trouble with leakage between the mouthpiece and the retort itself. It was difficult to understand how the supply of any normal quantity of the wet steam could possibly crack the mouthpiece. With regard to the choking of the aperture through which the steam entered the retort, he was thankful to say they had been completely free from this trouble, and he thought the reason must be that in the first case their steam supply was at the discharge end of the retort and not at the charging end, and, secondly, that it was placed on the opposite side of the mouthpiece to the offtake pipe, and therefore the rush of tarry vapours passing it was reduced to a minimum. He would suggest that the possible reason why Mr. Braidwood obtained better results with his rivet shaped nozzle was as much to do with the alteration of the position of the inlet relative to the offtake, as to the use of the nozzle he mentioned. A disadvantage of nozzles was that they must nullify the effect of the orifice plate, and that, therefore, the size of the orifice and pressure behind it could not have the normal relation for measuring purposes to the quantity of steam entering the retort, if the steam had to pass through such a nozzle.

They found a considerable advantage in introducing the steam at the discharge end of the retort in that they were able to allow the coal to come much nearer to the charge mouthpiece than before. The steam carried the heat of the retort from one end to the other, and when steaming it was almost impossible to get a green end at the charge end of the retort even if the coal was allowed to come on to the mouthpiece.

It was very interesting to see Mr. Braidwood's figures for increased consumption of coke owing to steam. At the Fuel Research Station, although they had tried their very best to obtain this figure, which, of course, must exist, they had so far been unable to do so, the inference being that it was quite small.

In the case of steaming for three hours, in order to obtain the conversion which had taken place in Fuel Research retorts they must have used at least 50 lb. of carbon per charge, but their weights of coke per discharge are certainly nothing like 50 lb. less than when they were not steaming the retort. Therefore a considerable quantity of the carbon must be provided by the scurf of the retort.

Mr. Braidwood's costs per therm when using steam made doleful reading, but, of course, they largely depended on the fact that he had to reduce his charge. Capt. Shaw had indicated a way in which he thought this could be avoided—namely, by charging the normal quantity of coal and deferring the supply of steam until such time as retort will be hotter and the charge had shrunk to an extent which would allow a smaller quantity of steam to pass over the top. The efficiency of the conversion in this case would probably be so much greater as to produce a similar number of therms to that produced during the longer period of steaming with the larger quantity of steam.

Mr. R. Gray (Wandsworth) said that his Company had been practising steaming seriously. In May, 1933, they considered that it would be worth while to experiment on their retort settings, and they were fortunate in having at their Sutton Works some retorts with anti-dips, so no costs were involved in that connection. They fitted up three settings of fourteen retorts each with moderately good results. Unfortunately they could not tell exactly the results obtained from steaming, and they proceeded to fit up the remainder of the settings. The original results were maintained, and they were very pleased. In view of past experiences they thought it would be wise to continue as they were in order to discover any possible snags. But after six months they decided that the whole thing seemed very favourable, and they took a fairly big step in converting twenty-four settings at their Mitcham Works for steaming. This cost a fair amount of money, but they felt it was warranted. In March, 1934, they started steaming there, and obtained better results than at Sutton. At a later date they extended the practice to the Wandsworth Works, so that at the present time they were steaming at each of their Works on 62 retort settings in all, a total of 500 retorts. It was absolutely essential to maintain a good temperature within the charge throughout the steaming period. They had deliberately reduced the temperature to under 1,000°, and found that practically nothing happened. At 900° nothing happened at all. But if they could retain 1,050° to 1,100° very good results were to be obtained. The next essential was a good heat input into the settings, and here many would suffer when they applied steaming. They were satisfied that the heat capacity of the settings must be adequate and more than sufficient to overcome the heat loss due to the steam. A good margin of heat within the settings was most essential, and they were now taking steps to introduce producers in excess of the normal requirements in order to provide for this.

Mr. Gray also emphasized that the charges must be level, with a reasonable amount of free space above them. At Wandsworth they had 24-in. by 18-in. retorts with a large amount of free space. The contact between the steam and the top of the charge would be small. They commenced steaming with the charges as they had previously been, but they discovered that they were not achieving a great deal. They then increased the charge and extended the carbonizing period to fourteen hours. They had felt that the large retort of 24-in. by 18-in. had disadvantages, and they were taking steps in their reconstruction to reduce the size of the retorts to 24-in. by 16-in. in order to have only a reasonable amount of free space and get better results from steaming.

He stated that one must have very positive anti-dips. At the Sutton Works their anti-dips were of the slide valve type. They satisfied themselves that these were tight at first, but they discovered that the faces of the valves became affected due to the excess steam used in the early stages of the experimental work. They satisfied themselves that the lower results were due to leaking anti-dips, and they replaced these with another type, which resulted in a return to the original results. Therefore, positive anti-dips were absolutely essential.

In regard to the use of superheated steam, they did not use this and did not think there was any real need for it. He mentioned that they originally used coke plugs at the ends of the retorts, but they found that the introduction of steam caused condensation—a large amount of the steam being condensed on the top of the charge. So they gave up the use of these plugs entirely. On one setting at Mitcham they were introducing heated steam, but they had not ascertained whether there was any definite advantage in so doing. In any case, he could not see any advantage in using highly superheated steam. He could not agree with Mr. Braidwood that the adoption of steaming was bound to involve a loss of throughput. Their experience was the reverse. They had been able to maintain their throughput and increase their make by 8%; so it was obvious that if they had increased in this way, without additional cost, their cost per therm must have gone down.

Referring to costs, Mr. Braidwood had made no allowance for benzole extraction. He thought the author would agree that he had been unfortunate in making a gas of 480 B.Th.U. Their experience at Wandsworth was that steaming was a blessing in compelling them to put up their calorific value in the retort houses. Their declared calorific value was 500 B.Th.U., and they made it at 530 B.Th.U. in order to allow for benzole stripping. Therefore the initial coal gas must be made in the region of 550 to 560 B.Th.U. They were satisfied that without this good

results could not be obtained. If Mr. Braidwood had had better conditions—and Mr. Gray could not visualize the condition of the retorts at the time—he did not know whether he was compelled to pull in order to get gas at 480 B.Th.U.—it seemed to him that he could have obtained a higher calorific value with the steaming and include benzole extraction at the same time. The conclusions they had come to were that steaming could not be applied generally, and anyone who said that because he had horizontal retorts he could do so would be wrong. One must be satisfied that the conditions were suitable for steaming, and having satisfied himself on this point there was every chance of success. In conclusion, Mr. Gray said that they had derived considerable assistance from the Fuel Research Station in their work, and he would like to express appreciation of the help of Capt. Fraser Shaw and Dr. King.

Early Experiments in Devonshire.

Mr. R. F. Rew (Devon Gas Association) thanked the President for the opportunity of attending that meeting of the Association and for their hospitality. He had read Mr. Braidwood's Paper with extraordinary interest, and it was difficult to offer any criticisms or comparisons without being reminiscent. The circumstances connected with the experiments of twenty years ago as applied to small gas undertakings were so very different from the conditions which obtained to-day at Beckton. The shortage of coal due to the war and to post-war coal strikes were the conditions which led up to their steaming experiments, in an attempt to eke out their coal supplies after having exhausted the stock of sawdust at the local saw mills and the " fir tree slabs " which the Canadians had left behind them. Their attempts at steaming immediately brought about the results they were looking for; but the expense and inconvenience of obtaining the additional 25% of their gas output from a given quantity of coal provided most of their difficulty.

There was this great fundamental difference between their experiments and those carried out by Mr. Braidwood. The entire benefit—from 7½ to 10%—which he had derived was brought about by what might be described as " surface scavenging," whereas in their case they could only obtain results by mass scavenging—that was to say, by passing steam through the charge as it lay in the retort. With their short 9-ft. retorts surface contact was perfectly useless, and simply added to the contents of their liquor well. They soon found that wet steam at any pressure was a thing to be avoided for every reason and that heated steam was a *sine qua non*. Obviously all forms of loose tiles and superheated pipe coils laid on the floor of the ordinary retort was a thing to be discarded. As result they brought the channel retort which for all purposes except where a charging machine was in use was perfectly satisfactory. Time contact was another essential feature, and it was only by means of trickling steam up through the burnt charge that they could obtain satisfactory results. Steam pressure, as such, was therefore of no importance, and in their case never exceeded 12 in. water pressure. They therefore inserted into the front wall of the settings a heavy cast-iron box with a mid-feather, into which a tiny stream of water trickled. This had the effect of keeping the cast-iron superheater reasonably cool and brought their superheated steam right up within a few feet of the point of contact.

They endeavoured to obtain a superheated steam by building in a battery of 4-in. steel pipes immediately above the retort arch; but they found the heat at that point insufficient, and the loss of heat even in lagged pipe between the outlet of this type of superheater and the retort itself was very rapid, so that this form of pre-heating had to be abandoned. With the channel retort supported by tiles underneath and the cast-iron box superheater and water drip feed it appeared that they had solved the problem of steaming. But at the end of about six months they were faced with the most serious difficulty of all, namely, that there was a definite tendency for the steam to make its way to the hottest part of the retort and to set up local fusion and disintegration of the retort itself, completely ruining the retort at this point. On this account, and this only, the process of steaming had to be abandoned in the absence of any material which would retain the steam on the inside of the retort.

During these experiments no fewer than seventy gas engineers, many being prominent men in the Industry, visited their small Works, and most of them gave it a trial. In fact, 180 gas undertakings were ultimately interested, although with the return of a plentiful supply of coal the steaming process was put on one side; but its temporary adoption proved to a large number of small gas undertakings the great advantages that some form of water gas production possessed, and as a result a large number adopted that method of gas production. Mr. Braidwood had mentioned the important part that steaming played on the formation of scurf. They also soon found that this nuisance was conspicuous by its absence, and they occasionally had to cease steaming so as to seal the crack in the porous parts of the retorts. There was also the reduced gas throughput from the retort to be considered.

Considering all things, he was rather of the opinion that while the subject was a most interesting one, and a process which might prove of considerable value during times of coal shortage, in a general way the benefits did not warrant the attention and additional costs which steaming must inevitably entail. These were his candid conclusions after four years of experiments, and if steaming was to come it would be by steaming over the charge and not through it.

Mr. Braidwood replied briefly to several of the points which had been raised in the course of the discussion, and intimated that he would like to deal with the main points in writing.

Vote of Thanks.

Mr. H. C. Smith (Tottenham) proposed a hearty vote of thanks to Mr. Braidwood for his Paper, remarking that there had been a tendency in recent times to decry the importance of manufacture. Those like himself who were responsible for making, distributing, and selling the gas could appreciate the work of the sales department; but it was no use trying to sell gas if it could not be produced at a price at which it could be sold. If it had not been for savings effected at the works by increased efficiency in manufacture they would not have been able to face the increased cost of selling. They must strike a better balance.

Mr. R. H. Ruthven (Ramsgate) seconded the vote.

Metrogas A.O.S. Gives "Rose Marie"

The fact that " Rose Marie," apart from its delightful music, was made famous principally by its " Totem " dance would be enough to deter many non-professional operatic societies from attempting it. Not so the Metrogas A.O.S., who gave four performances of this favourite musical play at East Greenwich last week, with an unbelievably brilliant " Totem." Miss Norah Webber, M.A.O.D. (Adv.), who produced the play as well as arranged the dances, must indeed have been proud of her chorus of ladies as they carried through the complicated evolutions with a professional perfection which gave a thrill even to the blasé dramatic critic. Not in this number alone, however, was the chorus work excellent, and both ladies and gentlemen made the very most of the opportunities which the play offers both to voice and limb. A Gavotte Interlude in Act 2 was particularly charming, and the men's rendering of the " March of the Mounties " would be hard to beat in any company whatever.

In addition to producing the play, Miss Webber gave a brilliant character sketch of the sinister half-breed, Wanda, around whose machinations so much of the drama pivots. Her solo introduction to the " Totem " dance no doubt had much to do with the high standard which the chorus achieved in this number. Rose Marie la Flamme was perfectly sweet, which does not mean that she began and ended there. Indeed, Miss Doris Brown's every movement, and the ease with which she achieved her transitions from mood to mood, must have been a joy to the producer, while her rendering of the musical numbers made it quite clear that she is a musician as well as possessor of a voice. Miss Grace Pickering resisted without the least difficulty any over-playing of Lady Jane—a temptation to which a less experienced actress might easily have fallen—and revealed herself as a true humorist. Little is expected of Jim Kenyon except to look nice as a reformed bad character, which Mr. Francis Harling took in his stride, and to make us love still more the delightful " Rose Marie " music, which presents no difficulty whatever to anybody with Mr. Harling's voice. However, he made the very most of his few dramatic opportunities, and his tender moments with Miss la Flamme were entirely artistic.

Mr. Elwyn Price achieved one of the outstanding successes, making his Sergeant Malone exactly the lovable type of Britisher who can still give five hundred years' start and a thousand mile beating to others who aspire to Empire building. Hard-boiled Herman warmed more and more to his task as the evening wore on, and as he obtained increasing measures of the help from his audience which is so beneficial to the comedian. In fact, one wondered whether the back seats did not perhaps miss some of Mr. William Bone's best lines until they became more skilled in reading them through his super-Hensonian facial contortions. Smaller parts were ably sustained by Miss Anne Matlock and Messrs. George McAlister, Harry Harding, and Charles Prosser. It was a pity Blackeagle had to be killed off so soon; he was a first-class blackguard.

Miss Webber's beautifully balanced production of the play was supported by splendid back-stage work, scenery, and costumes. And if any sceptic thinks that electricity is an essential of good stage lighting he should have seen the dawn breaking over the " Castle " in the Rockies as Jim Kenyon cast aside his matutinal pipe to engage Rose Marie at last in a long satisfying embrace. A pity, that pipe; Mr. Harling is too good an actor to need anything to play with while working up to so well staged a climax. But still, that is a small matter.

One complaint must be voiced. Why didn't the company insist on the Musical Director taking a curtain with the rest of them? One could only see from the auditorium that Mr. A. E. Harvey possessed a hand and a baton. The music, both stage and orchestral, was so very good that one longed to see what else there was of him. W. R. K.

Coal's New Industry—
The Production of Oil

by
F. S. SINNATT,
C.B., M.B.E., D.Sc.

An extract from a Paper presented at the First National Coal Convention, organized by the Coal Utilisation Council and held at the Hotel Victoria, London, on Nov. 21 and 22.

Last month the Billingham plant of Imperial Chemical Industries for the hydrogenation of coal was opened by Mr. Ramsay MacDonald. The progress of this new industry has aroused public interest in an issue of high national importance. The industrial success of the country was founded on cheap supplies of indigenous coal. Within this century, new machines, burning oil, have been perfected and found increasing use. By converting coal into oil and spirit, technical ingenuity has bridged the gulf between the solid fuel, with which Nature has endowed Great Britain, and the liquid fuels, which have had to be imported from abroad.

The hydrogenation process is one of the latest methods by which oil can be produced from coal. It is unique in that it is, or can be, a self-contained industry, turning coal into oil almost without residue or by-products. But this success must not be allowed to over-shadow other established methods and, since they in their turn may be modified by the hydrogenation technique, this seems an appropriate time for a brief review of the situation.

The underlying principle of all processes for producing liquid hydrocarbons from coal is that of increasing the ratio of hydrogen to carbon. The extent to which this change must be carried out can be gauged from the table.

Material.	% of Hydrogen by Weight.
Coal	4·5 to 5·5
High-temperature coke	up to 0 4
High-temperature tar	6·5
Low-temperature coke	3·0
Low-temperature tar	8·0
Product from tar hydrogenation	11 0
Product from coal hydrogenation	9 5
Petroleum	13·0

When coal is made to react directly with hydrogen, the product can be enriched almost to the level of natural petroleum. The alternative methods of making oil are by carbonization at high and at low temperatures, and by synthesis from water-gas or other carbon monoxide and hydrogen mixtures. The first two of these are essentially destructive distillations of coal. They yield volatile products, gas, spirits, and tar containing a greater, and a residue containing a smaller, proportion of hydrogen than the original coal. The synthetic method is hardly established on the industrial scale as yet, but it is interesting to speculate on the place it may attain in the future.

High and Low Temperature Carbonization.

The production of oil from coal by carbonization has often been assumed to be a matter of the utmost simplicity. It has attracted the attention of inventors from the time of Dundonald, but it is unfortunate that sometimes their technical equipment has been insufficient for the development of their ideas to industrial success.

In none of the systems of carbonization practised at present is oil more than an important by-product. In high-temperature carbonization the aim is to produce the maximum either of gas or of coke suitable for metallurgical purposes. A considerable proportion of the hydrogen present in the coal therefore appears as gas and the yield of tar is low. The carbonizing industries produce, however, 30 to 40 million gallons of benzole a year, which is largely used as motor spirit. In the coke-oven industry practically all the installations recover the benzole, but only a few gas-works are equipped with the necessary plant; a greater yield of benzole may be expected from the Gas Industry in the future. In 1934 17·9 million tons of coal were carbonized in about 1,300 gas-works and 1,127,000 tons of tar from this source were distilled. The corresponding figures for the coke-oven industry were 16·9 million tons of coal carbonized, and 611,000 tons of tar distilled. The total tar produced by high-temperature carbonization therefore amounted to about 1,700,000 tons. Much of this is used as road-making material, but from its distillation 80,000,000 gallons of creosote are produced annually. This creosote is valuable as a wood preservative, but it can also be readily hydrogenated to yield an equal volume of motor spirit, containing 40-50% of aromatic hydrocarbons. Thus the coal-tar industry could provide twice its present output of motor spirit. There are, however, other outlets for creosote; it can not only be used as a furnace oil, but be made suitable for high-speed diesel engines by the addition of pro-knock compounds, and promising experiments in the direction of re-designing the diesel engine to suit this fuel have been made. The general trend of the price of creosote suggests that the amount available on the market may not be sufficient to meet the demands of industry.

Hydrogenation.

The application of the hydrogenation technique to the crude tar from coke-ovens or from horizontal retorts is a difficult matter. However, about half of the coal carbonized in gas-works is treated in vertical retorts and recent work at the Fuel Research Station has shown that tar from these, particularly when steaming is in progress, lends itself more readily to hydrogenation. The carbonization of cannel coal in vertical retorts at high temperatures is also of interest in this connection. A high thermal yield of gas, 8·8 cwt. of coke suitable for domestic use, and 42·6 gallons of a tar as easy to hydrogenate as creosote were produced from each ton of coal.

New processes are being developed to carbonize mixtures of coal and creosote or coal and oil at low temperatures and give the maximum yield of motor spirit, but most of the methods have as their primary object the production of coke suitable for household purposes. If the temperature of carbonization is too low, the coke from bituminous coal loses some of its value for industrial purposes. On the other hand, experiments at the Fuel Research Station have proved that the tar is no longer suitable for simple hydrogenation if the temperature exceeds about 700°, so that some compromise must be made in industrial practice.

Last year 322,000 tons of coal were carbonized by low-temperature processes and the average yield of tar was 16 gallons per ton. It is understood that during the last six months Low-Temperature Carbonisation, Ltd., who are responsible for most of the output, have obtained over 17 gallons of tar per ton, in addition to 3 gallons of motor spirit. Low-temperature tar, like creosote, can be converted by hydrogenation into an equal volume of petrol, and Imperial Chemical Industries announce that the plant at Billingham is designed to produce 50,000 tons a year from these two sources. The petrol is high in anti-knock rating, some produced at the Fuel Research Station having an octane number of 87. Alternatively, low-temperature tar can be distilled to give two-thirds of its volume of a neutral oil which has the same possibilities as creosote for use in furnaces and in diesel engines.

The fourth method of producing motor spirit from coal has been developed by Fischer and Tropsch. By adding hydrogen to water-gas or removing carbon monoxide from it, the hydrogen-carbon monoxide proportion is altered to 2:1. The technical importance of this process is therefore that it provides a way of using coke, and that it can be worked in conjunction with the carbonization of coal at high or low temperatures.

The synthesis from the carbon monoxide-hydrogen mixture resembles Sabatier's formation of methane, but takes place at a lower temperature, 190°-200° C., in the presence of a more active catalyst. Nickel and cobalt have both been used with a variety of promoters which increase the rate of conversion. These catalysts are highly susceptible to poisoning by sulphur compounds, the concentration of which must be reduced to two milligrams per cubic metre of gas. The temperature of the catalyst chamber must be kept constant to within 5° C. and, as the heat given out in reaction is about 20% of the heat of combustion, this has proved a matter of some difficulty on the industrial scale.

In contrast to the hydrogenation of coal, this reaction takes place at atmospheric pressure.

The yield of liquid products is 100-120 grams per cubic metre of gas that contains 29% of carbon monoxide and 58% of hydrogen. They consist almost exclusively of straight-chain paraffins and olefines; their anti-knock value is therefore low, but on the other hand the synthesis can be worked to give excellent diesel fuel. In addition, the products can be converted by further treatment into lubricating oils of good quality. A small experiment unit has been set up at the Fuel Research Station with the object of developing the process in this direction.

Radiant Warmth Throughout the Home

Parkinson's New Catalogue

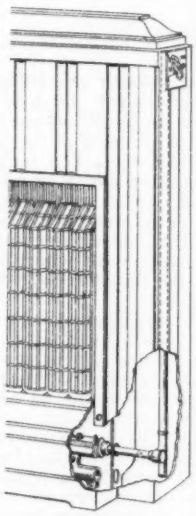
The consumer must indeed be hard to please who cannot find a gas fire to meet requirements among the wide range of attractive gas heating appliances described and illustrated in the new season's list just issued by the Parkinson Stove Company, Ltd.

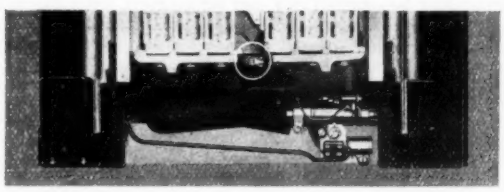
Quite apart from its general interest as a catalogue, dealing with all the firm's latest heating appliances, this production is notable for what we may term its "readability," its extremely attractive cover, and its pleasing lay-out and treatment of its various subjects throughout. In the foreword it is claimed that Parkinson's have a fire, suitable from points of view of efficiency, economy, and appearance, for every room in the house—a claim which is amply borne out by a glance through the subsequent pages.

The first section deals with the well-known "Curvex" fire, and sets out the advantages claimed for its particular type of heat dispersion. Attention is also devoted to the "Super-Ray" series of gas fires, which are very neat in design and embody a modified firebrick and a new form of radiant, so constructed that the maximum amount of heat is extracted from the flames and directed into the room. Other models mentioned include the "Panno" and "Welwyn" built-in fires. A new development of the former is the incorporation of a coin-operated time switch, which renders the fire peculiarly suitable for hotel bedrooms. The mechanism is fitted flush below the fire, and the insertion of 6d. into the slot automatically permits gas to be delivered for a period of approximately two hours. Should the tap be turned off before this period has elapsed the clock mechanism stops, so that the remainder of the time can be completed subsequently. Full particulars and specifications of all the models are given, together with examples of the attractive finishes in which they can be obtained.

The catalogue goes on to deal with other Parkinson heating appliances, including built-in fires and registers, the recently introduced "Zonex" portable fire, other portable models, the pleasing "Ubic" reflector radiator, the "Cabinette," the "Indusa," and other radiators, together with the "Compass" fire, which has been designed for the efficient heating of shops, hospital wards, and workrooms. With this heater warmth is distributed in all directions, the flue outlet being either directly upwards to the roof or downwards into a duct below the floor.

Most notable, however, of the Parkinson developments is the application of automatic ignition to their gas fires. The device operates on the battery principle, and a control tap at the top of the fire enables it to be lighted without stooping. The whole mechanism is completely concealed in the fire, as can be seen from the accompanying illustrations.





Showing the mechanism of the newly-introduced battery operated automatic ignition device on the Parkinson Stove Company's latest gas-fire models. The hand-level control switch obviates stooping.

Gas as an Industrial Fuel

We publish below a report of the Discussion which followed the Paper read by Mr. J. E. White at the Joint Meeting of the Manchester District Association of Gas Engineers and the Institute of Fuel (North-Western Section) at Manchester on Nov. 20. The Paper was published in last week's "JOURNAL."

The CHAIRMAN (Mr. A. L. Jennings, of Spenborough), in opening the ensuing discussion, said that Mr. White had not only dealt with the heat treatment of metals where the final product was of high price, but he had also shown that in several instances town gas had been used as a commercial proposition in connection with what could rightly be regarded as the heavy industries. He, the speaker, had personally been interested in some of the comparative costs stated, particularly those with reference to comparisons with oil. Mr. White had stated with regard to metal melting that with gas at 2·475d. per therm the cost per lb. of metal melted was 0·1d. If one-third was added to each of those figures, gas at 3·4d. per therm made the cost per lb. of metal melted 0·133d., whereas the cost with oil at 84s. a ton came out at 0·1314d. In other words, gas at 3·4d. per therm worked out at the same figure as oil at 84s. per ton. With regard to heating brass billets, Mr. White stated that oil at 84s. a ton gave a cost of 3s. per ton metal extruded, representing equal costs with gas at 1s. 6d. per 1,000 cu.ft. or 3·6d. per therm. It would be seen, therefore, that it was possible to account for the difference between approximately 2·4d. per therm for oil and 3·6d. per therm for gas by increased thermal efficiency.

This was what had been found in regard to processes operated in Newcastle. It would be interesting to know what other people had found In September he had had to deal with a metal-melting problem for which gas had never been used. It was stated that gas could not be used to compete with oil at 82s. 6d. per ton. The following figures showed how the problem worked out. Cost of oil, 82s. 6d. per ton; B.Th.U. value of oil, 17,840 per lb.; cost per lb. of oil, 0·442d.; cost per therm, 2·48d. Price of gas, 3·6d. per therm—45% dearer than oil. Cost per lb. of material melted in the case of gas worked out 2% cheaper than cost with oil. In other words, the efficiency of the gas more than counter-balanced the 45% extra price per therm of gas. This was a comparison of fuel costs only, and did not take into account any other savings effected by the use of gas.

As the result of the research work which had been undertaken he was pleased to say that the product was being manufactured by gas at the present time. The quantity of gas used was in the vicinity of 15 to 20 million cu.ft. per annum. The mill was a new one, and was gas lighted and heated, and the product made was dried by gas.

Dr. FELLS (Sheffield) thought that many people were inclined to think that Sheffield was the home of very cheap gas; and, as a matter of fact, they did have a great industrial load no doubt obtained by the correct pricing of their fuel. In his opinion, no fuel was more capable of accurate temperature control than gas. It was the fact that in former years gas furnaces had been built down to a price to such an extent that they had become merely boxes of bricks with burners inside

them. This was by no means true to-day. A modern gas-fired furnace temperature controlled, and atmosphere controlled where necessary, was more than a furnace; it was a heating machine of precision and should be considered as such. The perfectly bright annealing of silver was considered formerly to be a difficult matter to accomplish, but it could now be accomplished by means of gas and the installation of a suitable type of burner which would effect further combustion, no muffle being required.

Multiplicity of Electricity Tariffs.

Mr. ALBERT STUBBS (Metro-Vick), speaking as a member of the Institute of Fuel, mentioned that the electrical people had produced a multitude of tariffs which were really very embarrassing to industry; he hoped that gas producers would not follow too closely upon similar lines. It was desirable to get down to a standard tariff basis. Although he was to be regarded as a representative of an electrical concern, yet the firm with which he was associated was probably the greatest consumer of gas produced by the undertaking within its area. He wished to point out that great precision of temperature control could be obtained by means of an electrical furnace, and this fact should not be overlooked. He had in mind six electrical furnaces which were under continual control throughout the year, in which materials could be kept to within 1 or 2% of 1° C. at 400° C. or 500° C. This was a very high degree of precision.

Dr. DUNNINGHAM (I.C.I., Northwich) observed that the Gas Industry was in a somewhat peculiar position in that it was producing a gaseous product as well as a solid product both of which were used for fuel purposes. If the production of gas was increased, then automatically there was an increase in the production of coke. A market must be found for both commodities, and, as far as he could understand, the use of coal gas in industry was certainly not going to increase the market for coke.

Mr. H. P. LUPTON (Liverpool) said they had not the class of heavy industry in Liverpool to which Mr. White referred. They had been able to sell for furnaces for the light engineering trades gas at the price of 6d. and 6½d. per therm. Reasonably good business could be done on such lines. With regard to chain annealing, for instance, they had recently been able to put in a small furnace for doing 3 cwt. of chain per charge. The price of gas was 6·4d. a therm, while the price of coke had been 25s. a ton. It was found, after one year's working, that the cost of annealing the chains at 6·4d. per therm had been halved. Therefore, he did not think they had any cause to be frightened by Mr. White's wonderful figure of 2·45d. when they were going out to get business in the case of what he might term an ordinary undertaking. Quite a number of heating jobs in the engineering industry could be obtained on a basis of 6d. or 6½d. per therm.

Mr. A. L. HOLTON (Manchester) enquired whether, in the proportion of industrial gas sold at Newcastle, there was included supplies to bakeries and similar industries, or was the figure confined merely to furnaces for the iron and steel industries?

Mr. WHITE replied that the figure applied to industries generally.

Industrial Gas and Coke Sales.

Mr. HOLTON, continuing, could not agree that the cost of gas was represented merely by the coal and a little extra labour. A plant would have to be installed for its production if the existing capacity was exceeded which would involve the charging of a higher price. Were the varying prices mentioned in the Paper solely regulated by the two-part tariff or were they controlled to some extent by the nature of the job to be undertaken? Personally, he was paying particular attention to the supply of domestic coke, and he would like to assure all present that the Manchester Undertaking was not likely to arrive at the time when they would not know what to do with that product. All that was necessary was for the Gas Industry as a whole to improve its coke for the domestic market. This was being done rapidly, and even now the Manchester Undertaking, with the whole of its supply, could not provide every householder in Manchester with 1 cwt. of coke per week. There was not the slightest risk that because of the production of gas for industrial purposes coke would become more unsaleable.

Mr. D. M. HENSHAW (Chairman of the S.B.G.I.) thought that one of the strong points of the Gas Industry, both in its relationship to the domestic and the industrial sides, was that it endeavoured to maintain a balance in its economics. Mr. Holton had mentioned that the coke side of the Industry must not be overlooked merely because people were catered for who found gas to be a most convenient fuel. It should be borne in mind, also, that the Industry marketed quite a number of other by-products. Most districts could readily strike a balance in regard to the special requirements of their consumers. As Mr. Lupton had mentioned, there were towns where gas was not required for heavy industries, yet coke was being used by a considerable number of small industrial users who could probably be caused to realize the advantages of gas firing.

Mr. G. H. F. WINDIATE (Stretford) referred to the scaling of steels in forging operations. The undertaking with which he was associated had had a certain amount of experience with small forgings weighing from 8 to 28 lb. The forging was originally carried out by means of an oil-fired furnace. Gas was tried, but, at first, did not prove to be satisfactory, no better forgings being obtained than could be got from the oil-fired furnace, while the consumption of gas was somewhat high. The suggestion was made that some form of atmosphere control should be adopted. The original method of attempting atmosphere control was to operate the main burners, and put a highly reducing atmosphere into the furnace by means of excess gas. It was decided to operate the main burners at maximum efficiency, and introduce a certain amount of blower gas or purging gas. The results were remarkable. The over-all gas consumption was reduced by 20%, and the product was absolutely perfect. They were told that the saving in pickling and machining costs due to the reduction of scale more than paid for the gas consumed in the furnace. Atmosphere control had been found very satisfactory in relation to the annealing of non-ferrous metals like brass, copper, silver, &c. A point had been mentioned in regard to the amount of gas which was used by electrical manufacturers in Trafford Park. For the past three or four years the percentage had remained fairly constant at about 42 of the total gas sold for industrial purposes. The actual amount of gas sold for industrial purposes had increased very rapidly, and therefore, also, the amount of gas sold to electrical manufacturers. That was why the percentage figure remained fairly constant. Up to twelve months ago that was the greatest amount of gas sold to any one particular industry, but now the Building Products Industry were taking, approximately, 47 or 48% of the total gas sold in Trafford Park.

The CHAIRMAN, before calling upon the lecturer to reply to the discussion, said he quite agreed that the Gas Industry had a lot to learn from the electrical industry; as a matter of fact, it had a great deal to learn from everybody, and it was doing so every day. When the Gas Industry ceased to learn that would be the day when it would start to die; just as was the case with every other industry. The Gas Industry was not too old to learn, and it was not too young to teach.

The Author's Reply.

Mr. WHITE, in replying to the various points raised in the discussion, said he was particularly glad to receive the Chairman's comparison with respect to oil and gas; for the simple reason that it indicated that the object he had had in mind in preparing the Paper had been achieved. The price of oil per therm at 2·48d. was the exact figure that he had wanted to get home. He had found that in the actual sale of gas for industrial purposes there was a tendency to regard the price of oil at the 2·48d. figure, and to think that gas could only compete with fuel oil if sold at the same thermal price. Improved combustion, quite apart from other advantages that were associated with town gas, could make a very substantial difference in the price per therm.

The taking of coke oven gas by his Company, to a very large percentage of its total sales, had greatly helped in the establishment of prices which had made the industrial business possible. He had mentioned the potential fields that were available to the Industry in the early part of his Paper, and he would refer Mr. Lupton to the statements thereon. When the Newcastle Company formed its tariff it set out with a view to creating a price which was economic for the trades of its district. That was his reason for giving the very small percentage of really large consumers and the very large percentage of really small ones. The price of gas in Newcastle varied on the block system from 5·4d. per therm down to 3·06d. The number of consumers who were getting gas at 3·06d. per therm was less than half-a-dozen. The instances where he had quoted 2·475d. per therm were special contract rates, whereby a consumer undertook to take or pay for a given minimum quantity. It was found that under the present two-part tariff rate the widely diverging circumstances with which they were confronted could be adequately dealt with. With regard to the formation of the tariffs, they had aimed at simplicity. He was told by consumers that it was quite understandable to them. As a matter of fact, it amounted to a very small service charge, and some electrical people might be surprised to know it only amounted to 10s. per service pipe per quarter.

Dealing with price for electrical energy, when he quoted 0·6d. per unit he was being rather kind. That was the price per unit without a demand charge which he cheerfully passed over; so that in all probability the price per unit was substantially greater than 0·6d. per unit. He wondered if the 0·33d. per unit which had been mentioned had a proportionally greater standing charge attached to it. In his Company's area, quite recently, an installation went through in connection with the plating industry for the heating of plating tanks. The price was approximately 0·33d. per unit. The standing charge on top of that was such that he had been able to put forward for gas a price somewhere in the neighbourhood of 5·4d. per therm. So that actually the question of standing charges could have a very vital effect on the comparative costs of the two fuels.

The remarks respecting scale applied specifically to forging and drop stamping. Before he came into the Industry he was associated with straight engineering, and he had spent a considerable part of his life with drop hammers and forge hammers. He knew, from practical experience, that very light scale such as was caused by gas-fired furnaces, and which was a much lighter scale than any other type of fuel would cause, was not a serious disadvantage when handling heavy forgings such as the connecting rods of a locomotive or some equally large piece which had to be heated.

Mr. Holton had enquired whether the Newcastle scale of charges was entirely two-part tariff or did the "use" come into question. They had a price for one, and a price for all. There was no question of a special price for a special process. He believed the tariff had met conditions which applied equally to the small tailor as to the great industrial concern taking 150,000,000 cu.ft. per annum.

Upon the motion of the CHAIRMAN, seconded by Mr. A. L. HOLTON, a hearty vote of thanks was accorded to Mr. White for his Paper.

LONG SERVICE TO THE GAS INDUSTRY

A number of firms of long standing on the contracting and manufacturing side of the Industry have collaborated with the "JOURNAL" in the production of a series of articles, under the above title.

Donald Macpherson & Co., Ltd.

Previous articles in this series have dealt with some of the Firms who have served the Gas Industry in the development, to modern standards of efficiency, of the production, distribution, and utilization of gas. No less important to the Industry in another direction has been the work of Donald Macpherson & Co., Ltd., in developing improved materials for the preservation and decoration of Works equipment and appliances.

It was in 1885—the present year marking the Firm's Golden Jubilee—that Donald Macpherson founded the Firm and addressed himself to the task of applying in practice the principle of "Save the Surface, and you save all." He set himself in the first place to study the wonderful preservative values of the ancient Chinese lacquers, and his investigations culminated in the production of the original Foochow enamels, in which was developed a particularly hard and beautiful lustre. It is perhaps of interest to note that Diplomas for these products were awarded at the International Exhibition in France in 1885, the International Inventions Exhibition in London in the same year, and at the International Exhibition at Liverpool in 1886.

Some idea of the initial progress and national prominence of the Firm may be gathered from an interesting article which appeared in the *Queen* for Aug. 2, 1890, in which Mr. Macpherson was referred to as "the wizard of the North, and the manufacturer of that wonderful Foochow enamel, the uses of which are practically limitless." The common objects, indeed, which even in those far-off days were described as owing their distinctive finish to Mr. Macpherson's genius, included a very extensive range from the wooden heels of ladies' shoes to the humble tallow candle—the latter, incidentally, showing that Mr. Macpherson's products would cling even to a greasy surface. An idea of the quality achieved in these early materials is graphically shown by some of the Firm's original colour cards which, in those days, were made up from the actual materials, and the colours in which are still good to-day. And a cherished exhibit in the possession of the Firm is a paper-weight made from a solid lump of paint that had accumulated, coat upon coat, to a thickness of 3 in. on a door of the old Works where rough tests of obliterating quality were carried out. This lump of paint is as hard as bone, and in as good condition as though it was of quite recent application.

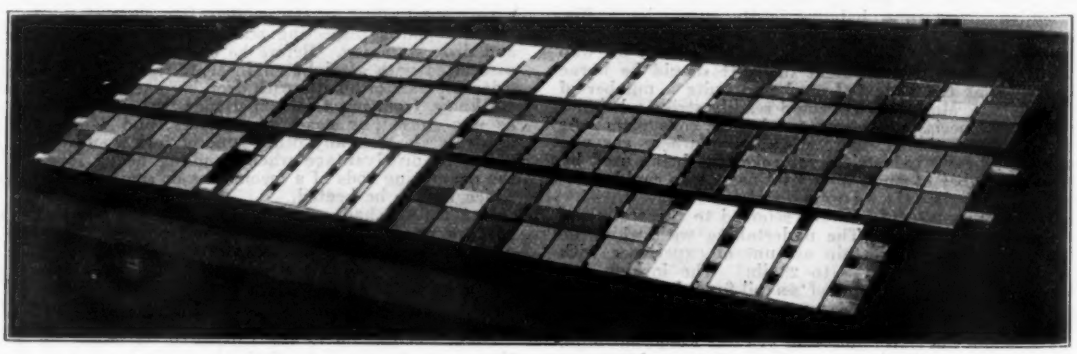
Special Productions for the Gas Industry.

The beginning of the Firm's association with the Gas Industry was in 1890, when special paints were introduced for gasholders, scrubbers, purifiers, and many other types of gas plant, as well as meters, lamp columns, cookers, and fires on the appliance side.

An important step in the progress of the Firm from its inauguration in 1885, with a staff of six, to its present position with two modern factories and a staff of over two hundred, was signalized by the establishment of the present Commercial Mills, Cornbrook, Manchester. From that time onwards continuous progress was made, and a succession of the new products affecting the Gas Industry was developed, including "Tamac" fire cement for building, patching, and repairing retorts, furnaces, flues, &c., followed by "Tamac" Plastic for cookers, stoves, grates, ranges, &c. And so expansion went steadily on until in the autumn of 1914 the whole resources of the Company, like those of so many others, were mobilized for the manufacture of paint for War materials such as guns, shells, lorries, mines, paravanes, ships, steel helmets, wire netting, &c.

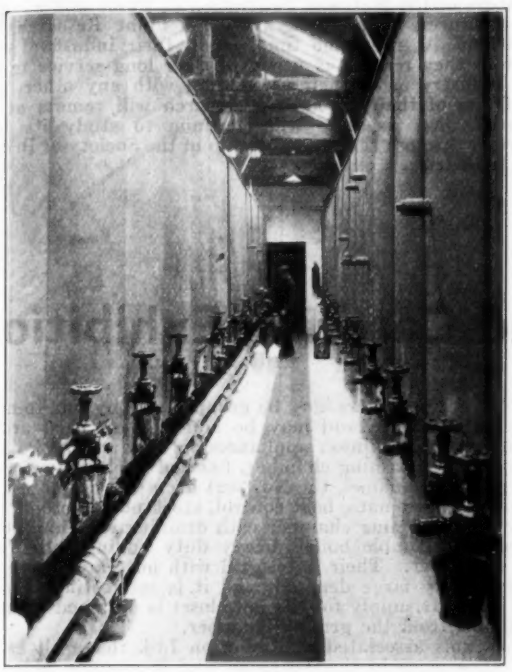
Post-War Expansion.

During this time the Company was under the guidance of Mr. S. W. Tamplin, who was Chairman until his death in 1923, when it was decided to carry on the Firm under the guidance of the three remaining Directors, Mr. F. H. Lamb, Mr. H. J. Lowe, and Mr. R. P. Chester, the last-named being appointed Managing Director. At that time the growing development of modern requirements was per-



Seaside Exposure Test Fence for "Foochow" Materials.

petually making fresh demands on the activities of the Firm. The significance of scientific research and investigation was fully appreciated, and with the help of qualified chemists and paint technologists a Research and Development Department was established, which remains to-day probably one of the best equipped in the whole paint industry.



One of the Aisles in the Varnish Store.

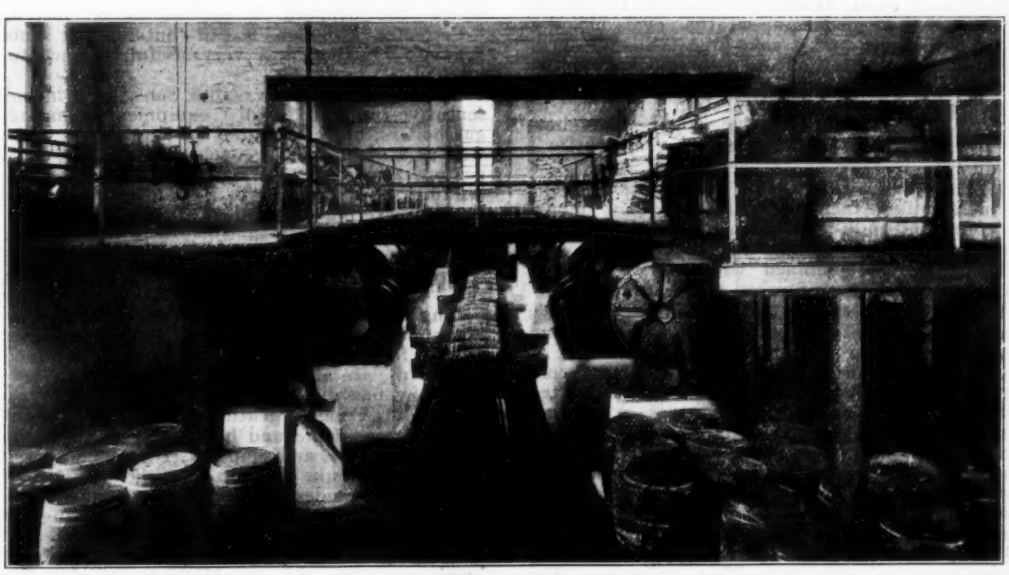
The next important landmark in the history of the Firm was in 1925, when a modern factory in the London area was established at Mitcham, where a new Cellulose Plant was erected to supply the growing demand for cellulose finishes for purposes of every conceivable kind, from tobacco tins to motor-cars.

In the years following the opening of the Mitcham Works rapid strides were made in the further improvement of anti-corrosive paints, and before long a better range of colours than had been possible with the old red oxide paints was able to be offered for gas-works uses. Mention might be made, for example, of a new permanent green, which placed fresh facilities at the disposal of gas undertakings for painting their holders and other structures in colours to blend with the amenities of their surroundings. Another direction in which the Firm's research work about this time was of special interest to the Industry was in the adaptation of lead paints to its particular purposes. Hitherto these had been generally considered as unsuitable for gas-works use, although recognized as one of the most durable types. Donald Macpherson were able, however, to offer the Industry various lead paints, which under exhaustive tests were proved to possess remarkable resistance not only to atmospheric exposure, but also to the most trying effects of fumes and other conditions with which they had to contend in the processes of gas manufacture.

Colour in the Home.

Donald Macpherson & Co. can justly claim to have been among the first to see the enormous possibilities presented to the Gas Industry in the development of synthetic enamels giving heat-resisting finishes, which would be easy to apply, requiring only short stoving times at modern temperatures, and by means of which gaily coloured appliances could be offered by gas undertakings to their domestic consumers. The part which such finishes have played in recent years in enabling the Industry to keep abreast of the modern demand for brighter homes is too well known to require elaboration. Suffice it to say that the Firm fully acknowledges the manner in which many leading gas undertakings have co-operated with them in developing these finishes to their present high pitch of efficiency. A fully equipped demonstration plant is available at each of

The new Lacquer Research Laboratory.



The new Automatic Grinding Shop.

their Works where the simplicity of producing a wide range of artistic colours has already entertained many members of the gas profession.

It is not without interest to record that a great deal of the machinery used in the Donald Macpherson Works has been designed and developed by their own Staff. A special machine which they claim has greater throughput, better wet-out, and better grinding efficiency than any other machine in general use was developed by one of their own technicians in collaboration with the manufacturers. Only last year the Manchester Works built and equipped an up-to-date bulk manufacturing plant at the cost of £5,000; separate motors are employed to all machinery so that maximum economy in plant operation is obtained.

It would perhaps be a surprise to many of their friends in the Gas Industry to glance through a catalogue of Messrs. Donald Macpherson's productions, and to know of the multitudinous trades for which they cater, including some of the world's largest industrial concerns. They are members of the National Federation of Paint and Varnish Manufacturers and of the National Paint Research Association. At the same time, of all their industrial connections they remain as proud of their long service to the Gas Industry as of their association with any other, and the fruits of their specialized research will remain at its disposal, just as they will continue to study its best interests through their membership of the Society of British Gas Industries.

INTERESTING DISPLAYS AT THE Hotel, Restaurant, and Catering Exhibition

The Gas Industry is well represented at the Hotel, Restaurant, and Catering Exhibition now being held at Olympia.

The B.G.F. Enquiry Bureau is certainly among the most striking stands at the Exhibition. The decorative scheme is worked out in cream, orange, and lesser amounts of black. Into relief panels, cleverly illuminated by gas, are fitted a well-assorted collection of photographs depicting various gas catering installations in all parts of the British Isles. There is also, available for distribution, a wide assortment of gas literature of interest to visitors to this Exhibition. The Bureau is kept at a comfortable temperature by the "Penrith" self-lighting gas fire which is manufactured by Bratt Colbran and the Heaped Fire Company, Ltd.

Next to the Enquiry Bureau and executed in the same style of decorative treatment with the exception of relief panels, is the exhibit of the Gas Light and Coke Company. Here an expert chef is demonstrating on a Benham "Solid-top" gas range which incorporates the new "Chef" burner which reproduces the conditions obtaining with a coal-fired range but with the added advantages of the cleanliness and flexibility of gas. This burner is specially suitable for fast cooking and vessels with concave bottoms can be let into the top of the hotplate without interfering in any way with the combustion of the gas. Also exhibited are Still's apparatus for tea or coffee, fitted with an egg poacher; the "T-A" geyser which, manufactured by Thermal Appliances, Ltd., was described in the "JOURNAL" early this year; Fletcher Russell's "Savoy" griller; a "Benham" steamer cooking at a pressure of about ½ lb. per sq.in., which it is claimed speeds up cooking by 25%; the Radiation "Guesthouse" range in three units which gives a very large number of different hotplate combinations and has a firebrick griller; and a "Freezolux" gas-operated refrigerator.

An old-established Firm, Benham & Sons, Ltd., exhibit a good selection of their modern apparatus. This includes hot closets, pastry ovens, and a coke-fired "Silver" grill with "Staybrite" steel exterior, and a three compartment wet-steam oven. Here is also on view the central "Solid-top" gas range as described in connection with the Gas Light Exhibit. Other exhibits include their smart hot-closet, carving table, and bain marie with "Staybrite" steel top.

Jackson Boilers, Ltd., exhibit their café fountain boiler, with coffee and milk attachments; latest "XL" model boiler with coffee and milk attachments; still-room boiler, with and without coffee and milk attachments; and gas-heated "Teatomaton," combined with boiler and tea brewer. All the machines are finished in chromium plate.

George Kent, Ltd., exhibit their "Ufix" caterer's boiler, with its patented interior ensuring rapid boiling and easy removal for cleaning; the latest standard boiler is fitted to receive urn connections, if so desired to "convert" it into a café set; the new "Redifix" café set, fitted with ½-gallon milk and coffee containers, is a compact portable unit to rest on the counter-top thereby avoiding the need for cutting; and a new domestic coffee percolator with which the making of good coffee becomes as simple as that of good tea. The walls and ceiling of the stand are panelled with George Kent, Ltd.'s, "Duropal," which greatly adds to its attractiveness.

The Parkinson Stove Company exhibit a selection of their comprehensive range of hotel gas cooking appliances. The Parkinson "Unita" cooker is of outstanding interest. This departure in design provides a unit system whereby the "Unita" cookers may be grouped side by side to meet catering demands, and may be added to as need arises. Among other Parkinson appliances on view are the Parkinson movable warming chamber, finished in chromium plate and porcelain enamel, the No. 3024 oven and hotplate with "Ajusto" automatic heat control, stock-pot on stand, fish fryer, and warming chamber with draining rack and hood, 10-gallon vegetable boiler, heavy duty boiling table, and café tea boiler. Their hotel grill with hot closet on stand meets a very large demand, and it is interesting to note that the heat supply for the hot closet is obtained through a channel from the grilling chamber.

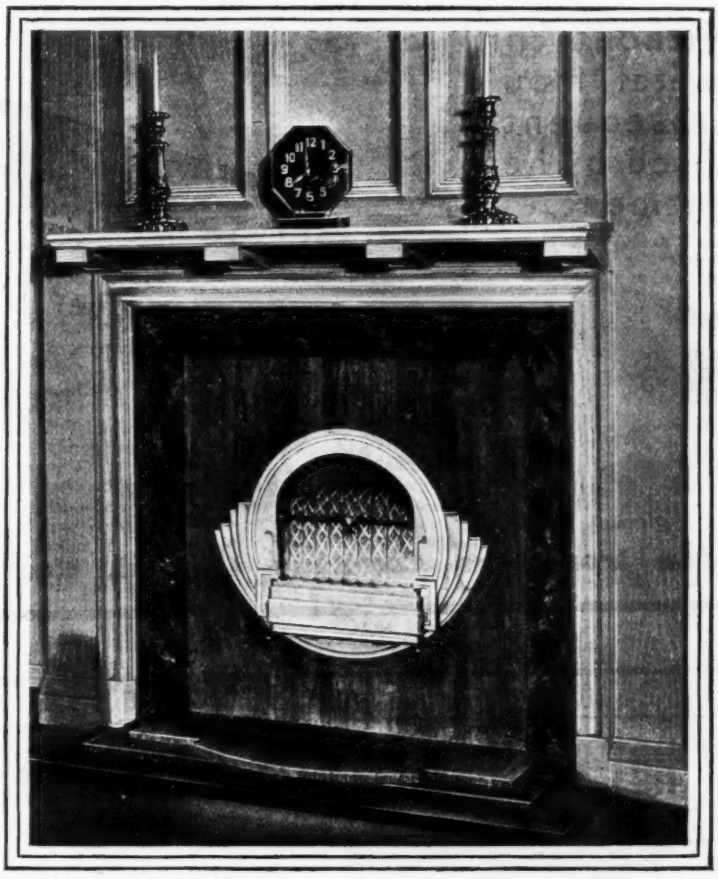
The firms associated in Radiation Ltd., have all had a vast experience in the designing and production of large-scale kitchen equipment. Primary interest in view of the development of automatic oven heat control attaches to the ranges incorporating this feature Of these, there is the "Bordo" "New World" range. The "New World" double-oven range (No. 89), for large kitchens, comprises two roasting and baking ovens surmounted by a continuous hotplate, and each oven has the characteristic "New World" features. A recent achievement of this Company is the "Guesthouse" series of ranges, which incorporates a unique system of assembly of "units," any number of which can be arranged. The range is always complete yet can be added to by removal of the end hotplate members and replacing them to include the additions. Also shown is the four-oven "Grosvenor" range of central type, capable of really heavy duty, yet flexible, and very economical in running cost, and an interesting vegetable and pudding steamer with an output of 75 lb. of potatoes. The "Grosvenor" four-oven central enclosed range incorporates many interesting features. The ovens are externally heated and are fitted with drop-pattern doors. The enclosed unit's hotplate has triple concentric burners with firebrick surrounds, over which are solid plates with rings. The range has self-contained flues. For making tea where the demand is continuous or intermittent the "Perfectea" boiler is an outstanding success. The "Savoy" griller is a very useful adjunct to the hotel kitchen.

The exhibit of W. M. Still & Sons, Ltd., includes a representative range of "Still" equipment including automatic gas boilers, hot closets and carving tables, and grillers, as well as a dish washing machine which can be adapted for gas operation.

James Stott & Co. have a comprehensive display of gas-heated catering appliances. Several recently improved specialities are being shown, the principal feature of each and all being economical operating costs, by means of their self-regulating character, and these exhibits comprise the "Stott" self-regulating water boilers, for providing boiling water for tea-making. Thermostatically-controlled hot cupboards and hot closets, and thermostatically-controlled food steamers, together with other food-preparing apparatus, are also shown.

A very fine display has been arranged by Sumerling & Co., Ltd. A special feature is the "736" eight-foot combined service table and hot cupboard with stainless steel vegetable, sauce, and soup vessels easy of access fitting into a top steam tank. Mounted overhead a steam-heated hot cupboard provides additional accommodation. In the body of the apparatus is an ingenious arrangement consisting of a wet steam compartment which keeps sweet and savoury puddings in an unspoiled condition throughout luncheon hours thus enabling a complete lunch to be dispensed from one apparatus. The whole appliance is operated by a single-bar gas burner.

TALKS ON HEATING APPARATUS



The story of the progress of heating equipment from the Middle Ages to the twentieth century would make most interesting reading. For example, compare the enormous fire grate of the Tudor period, that was found necessary to warm a reasonably large room, with the modern GLORIA Gas Fire which, sitting comfortably in the wall or panel and not encroaching on the room space, gives an abundance of glowing heat which is appreciated even in the farthest corner of the room.

The GLORIA is obtainable in 9 and 12 radiant sizes and provided with Duplex burners. There is a variety of finishes available.

GLORIA PANEL GAS FIRE

Catalogues for your Showrooms and folders for distribution to your consumers will gladly be sent on request.

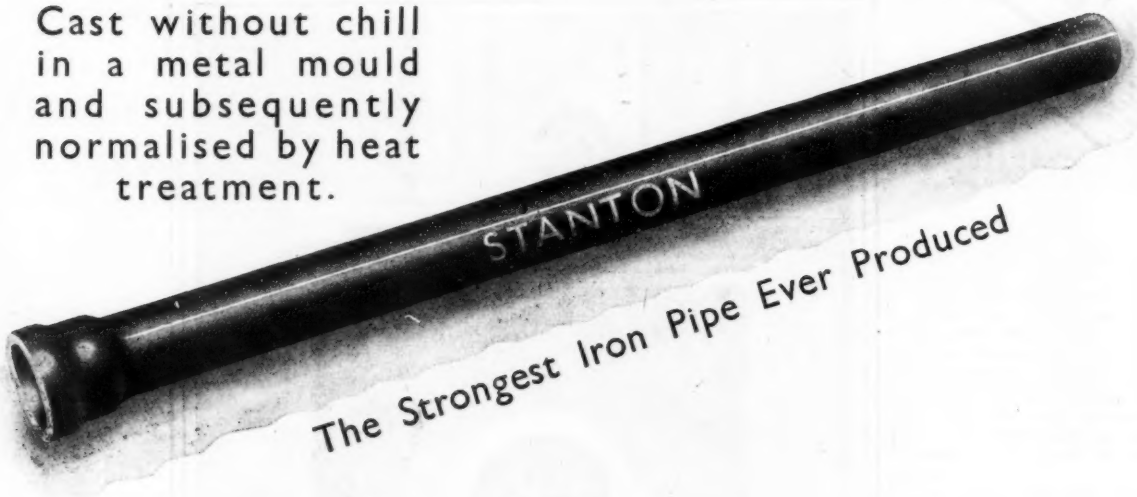
R. & A. MAIN LIMITED, LONDON AND FALKIRK

London Office and Showrooms: 48, Grosvenor Gardens, S.W. 1. ● Glasgow Office and Showrooms: 82, Gordon Street

STANTON NEW SPUN IRON PIPE

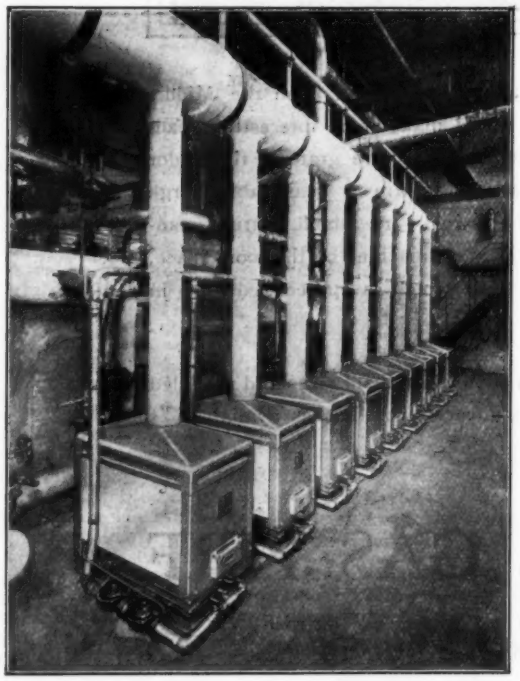
Manufactured under Delavaud and Mairy Patents

Cast without chill in a metal mould and subsequently normalised by heat treatment.



The Stanton Ironworks Company Limited, Near Nottingham

"DIRECT" HOT WATER SUPPLY for INSTITUTIONS, HOTELS, ETC.



The advantage of "Direct-Heating" for large systems is obtained by Potterton's D. Series "REX" Boilers (an example of which is shown), wherewith high-temperature water is quickly available by stratification without heating bulk.

"REX" Domestic Water Heaters, made in units of 66,000 to 198,000 B.Th.U. hourly, are provided with access to all flues and waterways for the easy removal of deposits without disconnection.

Fully Automatic—including Cut-outs.

← *Battery of "REX" Domestic Gas Water Heaters installed at the Public Baths for the Wandsworth Borough Council, in the area supplied by the Wandsworth and District Gas Company—capacity one and a half million B.Th.U. hourly.*

THOMAS POTTERTON (Heating Engineers), LTD.

Telephone: BALham 1244-5-6. CAVENDISH WORKS, RAVENSWOOD ROAD, BALHAM, LONDON, S.W.12. *Telegrams:* Potterton, Toot, London.

The Gas Companies' Protection Association

Thirty-Eighth Annual General Meeting.

The Thirty-Eighth Annual General Meeting of the Gas Companies' Protection Association was held at the Offices of the Association, 5, Victoria Street, S.W. 1, on Monday, Nov. 18, 1935—Mr. R. W. EDWARDS (Chairman) presiding.

The SECRETARY (Mr. R. Girdlestone Cooper) read the Notice convening the Meeting, after which the Minutes of the last Annual Meeting were confirmed and signed. Apologies for absence were reported from various members.

THE CHAIRMAN'S ADDRESS.

In moving the adoption of the Report of the Committee, the CHAIRMAN said:

The finances of our Association continue to be in a sound and healthy state, and the balance-sheet up to the conclusion of our financial year discloses an exceedingly satisfactory state of affairs. Copies of the Report and Accounts have been circulated to all our members. Your Committee continue to exercise exemplary restraint in their expenditure of the Association's moneys as witnessed by the fact that this is the fourteenth year in succession that our income has been more than equal to our disbursements.

Our present holding of War Stock shows a capital appreciation of £130 5s. 7d. over the cost price as it exists in the balance-sheet.

The income from subscriptions and donations continues to be highly satisfactory and most encouraging; an addition was again made to our reserves by the purchase of a further holding of War Stock amounting to £300, thus increasing our total in that respect to £3,000.

Our assets are valued at this time at £3,326 6s. 5d.—a most useful fund—and your Committee are to be congratulated on their prudence and foresight in the accumulation of this reserve.

National Position of Trade Generally.

Before passing on to a *résumé* of our activities in our own Industry, it has been my custom to make a few general comments on the situation at home.

The year now under review has been one of exceptional interest in a great number of ways.

All of us in our many and varied ways took part in the Jubilee celebrations as an expression of gratitude for a truly beneficial rule during one of the most troublous periods in our country's history. It is patent to every one of us that the past quarter century has been a time when great and momentous matters arose for immediate decision, and it redounds to the credit of our King and his advisers that such decisions were unswervingly adhered to.

Your attention has been drawn to the gradual but appreciable improvement in our country's trade.

There can be little doubt that the stability of our Government has contributed in no small measure to this long hoped for revival, and despite several alarms occasioned by certain international occurrences the general tone of the market has been upheld and the public has not been slow to invest in those concerns which were deserving of its support.

It says much for the soundness of our principal industries that despite the dislocation inseparable from the talk of a change of government and the very disturbed state of foreign affairs they have consistently maintained their position.

The building trade and allied industries have before them a long programme of work and should be in a position to view the future without concern. While we are not directly connected with the shipping world it is gratifying to note the distinct improvement in this branch of commerce on which our world trade was primarily founded; as a matter of interest, there are fewer idle ships now than for some considerable time past.

The coalmining industry is again being disturbed by rumours and alarms, and the spectre of nationalization is being brought forward as the only solution of the troubles. We as representatives of a part of the largest consumers of coal are vitally interested in this problem. It is a problem, for the miners appear to be underpaid; when present circumstances are considered, the collieries cannot in most cases make any higher payment out of profits, and we pay substantial prices for our supplies. It is to be hoped that the parties will settle their differences without recourse to the use of strikes and the consequent damage to trade and industry.

The Gas Industry.

The gradual improvement in the affairs of our country has naturally been reflected in no small measure on our own particular Industry.

Our commodity continues to find favour on all sides, and sales move steadily upward due in no small measure to the huge quantities of new apparatus that are regularly connected. The ingenuity of our engineers and manufacturers is ably shown in the many ingenious ideas which they carry into modern appliances, making them more useful and attractive and generally increasing their utility.

The important thing to remember on all occasions is "Service," and I feel sure that at no time in our history has the Industry stood higher in this respect.

An outstanding item in the past year was the success of the campaign initiated by the Gas Light and Coke Company in popularizing the gas refrigerator. Unprecedented demands had been made on the manufacturers, and some difficulty was being experienced in obtaining delivery of apparatus; but it opens up a very fruitful field to all of us and one which demands our attention.

Difficulty is being experienced by certain companies in establishing their right to instal gas apparatus in certain Council Housing Estates despite the fact that the tenants wish to have the supply and that no prohibition contrary to Section 27 of the Gas Undertakings Act, 1934, is in existence. It seemed an opportune moment to test the right of an owner of property to withhold the commodity and for any member experiencing trouble in this respect to move in the matter.

This is being done by some members, and it is hoped that any others who may be suffering from similar experiences will not hesitate to take action. The Committee will be glad to have details of any such cases as have not already been brought to their notice.

Holding Companies.

The difficult question of Holding Companies in the Industry has engaged the attention of many of us in recent months. Competition had been apparent between various groups without any real desire to limit such grouping to reasonable geographical limits with the fairly obvious result of excessive inflation of share values in certain instances. This unbridled competition was harmful to all concerned and detrimental to that grouping of concerns which in certain cases might be beneficial, where small undertakings could be physically linked up with a larger without inflation of capital and with no detriment to the consumers. It is to be hoped reason will prevail and that the efforts to limit the operations in suitable cases will be successful, subject to the most important point of all that such companies are run by gas-minded men with a wide knowledge of the Industry.

Although there were many attractions in London during the period of the Jubilee celebrations, few were so popular as the floodlighting of most of the famous public and historic buildings. The Gas Industry through one of its member companies exhibited a large scale demonstration of floodlighting, and I am happy to say that this effort was manifestly successful, for no more popular place than St.

James's Park and the Horse Guards' Parade could be found in London at that time.

The public view of the position which we occupy in their minds is abundantly reflected in the notable stability shown in the gas stocks of this country. Prices continue to stand at a high level with little general movement, probably owing to the general desire to retain what is after all a first-class investment.

Undeniably we have our difficulties, but they are as nothing compared with those confronting our most serious competitor, the electricity supply industry.

The year now under review has been one of comparative freedom from legislation or contemplated legislation, for which we are not ungrateful.

British Gas Federation.

You will remember that at the time of our last Annual Meeting it had not then been decided as to whether your Association should be included in the Federation.

After mature discussion your Committee came to the unanimous conclusion that it was in our best interests to join this body. Although the Federation has only been in existence for little over a year it has been of great use in co-ordinating the interests of the various National Bodies representing the Gas Industry, which consist of the National Gas Council, the British Commercial Gas Association, the Society of British Gas Industries, The Institution of Gas Engineers, and our own Association, and its Council is in effect the Cabinet of the Gas Industry to be under the Presidency of the Earl of Dudley during the coming year. Our representation on that body consists of Mr. F. J. Bradfield, Mr. C. F. Botley, Mr. F. G. Brewer, Mr. R. Halkett, and myself.

I wish to point out that all members of the Associations or constituent Bodies of the Federation are entitled to attend the Annual Meeting and if they so desire to speak thereat, but any necessary voting is retained in the hands of the nominees of the constituent Bodies appointed to sit on the Council of the Federation. It is hoped that as many members as possible will attend the first Annual General Meeting of the Federation, to be held on Dec. 11, 1935. Your Committee spent some time in considering the Draft Constitution of the Federation and satisfied themselves, after making certain acceptable amendments, that it was agreeable to us.

In addition to the representation which I have mentioned, the Federation has established a Panel composed of officers of the member bodies, and our Secretary represents our Association on this Panel. Meetings are held regularly and recommendations are made to the Council after due consideration of all matters which might affect the Gas Industry.

Without interfering in any way with a local undertaking exhibiting at an important Exhibition, the Federation proposes to organize a stand at National Exhibitions such as the Ideal Home Exhibition, under its own name, on behalf of the Industry generally.

British Industries Fair.

You will recollect that at about this time last year your Committee had under consideration the suggestion advanced by the Society of British Gas Industries that instead of the Industry exhibiting at this Fair it should concentrate on such as the Ideal Home, the Bakers' and Confectioners', the Shipping and Engineering, and similar expositions, and in addition substitute in place of the Fair a Triennial Gas Exhibition.

There were some grounds for this suggestion; the date of the Fair had been altered from February to May and primarily it was for foreign buyers who never could be consumers of gas in this country. The suggestion to discontinue our connection with the Fair was not one, however, that met with the approval of your Committee who thought that the Industry should continue to exhibit as heretofore unless some exceedingly cogent reason was given to the contrary.

I have already mentioned the British Gas Federation's intention to organize stands at the principal shows, and through its Exhibition Committee it intends to exhibit at the next Fair in February, 1936. A strong Committee has been formed and called upon to act under the name of the Gas Industries Section Committee, and you will appreciate what an influential body this is when I tell you that the following are represented thereon: The British Gas Federation, the Joint Gas Conference Committee, the City of Birmingham Gas Department, and the Birmingham Chamber of Commerce. Your Association is represented by the Secretary and myself.

Lee Conservancy Catchment Board Draft By-Laws.

The Lee Conservancy Catchment Board in pursuance of their obligations under the Land Drainage Act, 1930, had submitted draft by-laws to the Ministry of Agriculture and Fisheries for their approval.

Under such Draft By-Laws certain exemptions were given to Public Utility Undertakings, but curiously enough statutory Gas Companies were omitted.

The Tottenham and District Gas Company had made objection to the by-laws being confirmed as drawn and suggested an amendment. On the position being brought to the notice of this Association formal objection was at once made in support of the Tottenham Company asking that the Association might be heard in support of such objections.

There did appear to be a great danger of the Ministry creating a precedent inimical to the interests of our Industry throughout the whole country.

I am glad to inform you that the desired exemption was conceded and an amendment made to such draft by-laws for the benefit of Statutory Gas Companies.

Slum Clearance and the Electricity Supply Industry.

Last year I drew your attention to the difficult position that had arisen in connection with slum clearance and the building of new blocks of electrically equipped flats.

A strong Sub-Committee was appointed. Such Committee is now composed of Messrs. H. E. Bloor, G. Stevenson, A. S. Holden, Assistant Secretary of the South Metropolitan Gas Company (who took Mr. Stokes's place on his retirement), and C. W. Lawrence, Chief of the Gas Sales Department of the Commercial Gas Company.

A considerable amount of investigation has been undertaken by the Sub-Committee.

So strongly did your Committee feel on the matter that, following a recommendation of the Sub-Committee, all members of the Association have been circulated for information as to instances of the like nature. We as an Association feel most keenly the very biased attitude of certain electricity undertakers—a bias that seems to blind entirely their sense of fair dealing which we had believed, perhaps erroneously, was common to the British nation.

In view of further developments your Sub-Committee have not yet felt themselves in a position to make a report.

London Building Act, 1930 (Amendment), Bill.

The London County Council promoted a Bill towards the end of the Parliamentary Session in order to amend the London Building Act of 1930, and this duly came before your Committee for attention.

The general object of this Bill was to enable the Council to make by-laws in substitution for certain provisions of the principal Act, which would be likely to affect gas undertakings. There was also the probability that the provinces might follow the lead of the London County Council.

After a very full consideration of the Bill, your Committee came to the view that we had no cause for complaint unless and until any by-law should be proposed that was deemed to affect any of our member companies. Concurrent with our deliberations the National Gas Council gave their attention to the same matter and came to an identical conclusion.

The publication of any draft by-laws would require the confirmation of the Ministry of Health, and in the event of any of such by-laws being detrimental to the use of gas, representations could and would be made to the Ministry regarding their amendment, in conjunction with the National Gas Council.

Metropolitan Water Board Bill.

In view of the possibility of danger to Companies operating in the area covered by the Metropolitan Water Board it was deemed advisable to write to all our members within that area calling their attention to the Board's proposals.

This Bill contained powers enabling the Board to construct substantial works in the Counties of Surrey and Middlesex.

Our members were advised to get into touch with their respective Parliamentary Agents and consider the desirability of seeking further protection than that offered by the Bill.

Association of Public Lighting Engineers.

The Twelfth Annual Meeting and Conference of the Association of Public Lighting Engineers was held in London in September last under the Presidency of Mr. A. Maurice Bell, the Public Lighting Superintendent of the Tottenham and District Gas Company.

This Association was invited to send a delegate and we

were fortunate in having the able services of Mr. E. J. K. Fussell available to represent us on that important occasion.

Conjoint Conference of Public Utility Associations.

Our Association is represented on this Conference by six representatives and the very closest collaboration has been maintained throughout the year and I wish to pay tribute to the increasing value of the work done by that body and the willingness of its officials to be of any assistance to us.

(*a*) *Goods Vehicles (Keeping of Records)—Regulations, 1934.*—In furtherance of the work that was done in this connection in 1934 the negotiations with the Ministry of Transport were continued. The Ministry informed the Conference that following advice received from the Transport Advisory Council the Minister proposed to publish draft revised Regulations.

Subsequent to the receipt of such regulations several slight modifications were made with the object of simplifying the keeping of the necessary records rendered obligatory by Section 16 of the Road and Rail Traffic Act, 1933.

Individual application by members of the Association for exemption had been unsuccessful, and the efforts of the Conjoint Conference appeared to be the maximum that the Ministry were prepared to concede. A memorandum containing some useful information was subsequently issued by the Ministry explaining the requirements in the records now stipulated as being necessary, and your Committee, by means of a circular to its members, drew their attention thereto.

(*b*) *Breaking up of Highways.*—Our difficulties in the ever present problems of the laying of mains in highways do not decrease—rather the reverse—and I regret to inform you that the negotiations which were taking place between the various public utility interests and the Highway Authorities have broken down—temporarily only I hope.

The joint Negotiating Committee composed of representatives of the Highway Associations and of the gas and electricity interests had reached agreement on a draft clause dealing with this question which had been submitted to the individual associations for further consideration.

The gas and electricity interests agreed the clause in principle, and their representatives were to continue negotiations on the Joint Committee for the purpose of obtaining certain modifications. Only the County Councils Association seem to have been against the proposed clause, and unfortunately turned it down.

On this being reported to the Conference the water interests made the suggestion that the Executive Committee of the Conference should consider the matter, and since that date I know that the position has improved. It is much more satisfactory that the three utilities should move together toward what is, I hope, the accomplishment of a long drawn out but very necessary settlement of the difficulties.

It is worthy of note that the clause has recently been incorporated in a Gas Order at the instance of a certain County Council.

The immediate effect of the breaking-off of negotiations was the stiffening of the attitude on the part of County Councils, as the Highway Authorities, who became exceedingly aggressive in certain instances with regard to our undeniable rights and powers to place our mains and apparatus on or in highways.

The Conjoint Conference drew our attention to the attitude of one County Council which had introduced a form of what the Council were pleased to call a " Road Opening Permit " that purported to lay down certain conditions and regulations to be observed when a county road was broken up or trenches were to be reinstated.

In order that none of our members might be prejudiced by such tactics a circular was issued drawing attention to the rights of Statutory Gas Companies in this connection and advising that any such form of agreement should be ignored.

It is, of course, not the first occasion that we have had to deal with this attempt to undermine our position, and I do ask that any member receiving such a form should communicate with this Association.

Later in the year your Committee had again to draw attention to what was apparently a concerted effort by the same bodies to bring pressure to bear in an endeavour to compel public utility companies to insert clauses of an onerous nature for the protection of the Highway Authorities in their Private Bills and Orders. Here again we must stand as a body and accept nothing as individuals that would not be acceptable to us all as members of this Association.

(*c*) *London Passenger Transport Board Bill.*—This Bill was very carefully considered by the Committee in view of certain clauses as to new works, street openings, &c., and while a measure of protection was offered in the Bill as deposited to utility undertakers, it did not go so far as two precedents that had been obtained in other directions. Seeing that several members might possibly be affected by this Bill, it was arranged to discuss the matter with the Conjoint Conference to see what could be done.

The outcome of such combination was the circulation of a draft clause, which it was hoped to include in the Bill, to all members in the area affected after your Committee had provisionally approved the same.

Apart from one member company which was specially affected, the clause was generally acceptable and gave adequate protection to our members' interests. I am glad to say that the Conjoint Conference came to the conclusion that further protection was necessary on the following:

(*a*) Access to the apparatus of public utility undertakers should not be impeded.
(*b*) The minimum cover left over apparatus of undertakings should be specified in the Bill.
(*c*) The value of any gas (or water) lost because of the authorized works should be paid for by the Board.
(*d*) Notice of intention to carry out the authorized works should be given to public utility undertakers.

It is satisfactory to report that a clause covering the foregoing points was agreed with the Promoters of the Bill, and there was no necessity to proceed to deposit a Petition against the proposed measure.

(*d*) *Housing Bill.*—Difficult questions had arisen in connection with the possibility of compensation being payable in respect of Housing Schemes under the Housing Act, 1930. Considerable doubt existed as to the basis upon which compensation was payable to public utility undertakers.

The Conjoint Conference felt, therefore, that this Bill was a favourable opportunity for the Government to clarify the position as to the assessment of such compensation.

Utility undertakers had made available to slum dwellers the amenities of modern life in the form of gas, water, and electricity, and it seemed inequitable to penalize such undertakers who were in no way responsible for the position and, in fact, had done everything in their power by means of their services to ameliorate the position.

Following on an amendment put down by the Conference to Clause 13 of the Bill, the Government signified their acceptance thereof, and provision is now made for notice of all housing schemes to be served upon the public utility undertaking in the area concerned in the scheme.

As a result of representations to the Ministry of Health, a further amendment in the form of a Compensation Clause covering the payment for mains rendered useless by re-development schemes and apparatus and appliances belonging to undertakers in houses scheduled for demolition was drafted and approved by the Committee of the Conference.

Eventually this amendment was accepted, and, in addition, undertakers were also protected by exempting their land from the liability of being compulsorily acquired by Local Authorities. Additional protection in other directions was also secured, and I think our Associations are to be congratulated on the work which they have done in this direction.

Housing (Scotland) Bill.

This Bill followed very much the lines of the English Bill, and the provisions relating to public utility undertakers were very similar. While the Bill was in Committee the Conjoint Conference secured for our Scottish friends similar rights to those we had been granted, most important among them being a Compensation Clause.

There is one notable distinction between the two Bills. In the English Bill public utility undertakers are referred to as Statutory Undertakers, whereas in the Scottish Bill they are referred to as public undertakers. The effect of this distinction is therefore that in Scotland all public utility undertakers—non-statutory as well as statutory—will be entitled to the privileges and benefits accorded by the Bill, the reason for the apparently additional concession being this—that non-statutory companies are liable to be compulsorily taken over by a Burgh at any time.

(*e*) *Restriction of Ribbon Development Bill.*—The fundamental object of this Government Bill was the prevention of housebuilding along the sides of classified roads, except of course, with the consent of the Highway Authority.

The erection of buildings within specified distances of these roads was prohibited, save by consent, and restriction was placed on the access to the same roads.

Protection was given to the rights of public utility undertakings, but the Conference felt that further safeguards were necessary. A Memorandum on the subject circulated by the Conference was under consideration by your Committee. Many very important details were duly considered and suggestions made to the Conference for incorporation in the amendments.

The Conjoint Conference later entered into negotiations

with the Ministry of Transport and secured an amendment which ensured that no restriction shall apply to any works necessary for the repair, renewal, removal, &c., of the existing apparatus of undertakers. The Bill became law on August 2, 1935.

(*f*) *Land Drainage Act*, 1930.—The Drainage Boards constituted by the Land Drainage Act, 1930, throughout the Country were engaged during the year in assessing hereditaments within their respective areas for the purposes of a drainage rate.

The Act provided that the drainage rate in respect of a hereditament which was assessed for the purposes of Schedule A income-tax should be based upon the gross annual value as determined for the purposes of Schedule A. No express provision was made, however, for the assessment of hereditaments such as our undertaking, which were not assessed for the purposes of Schedule A income-tax.

Differences naturally arose, seeing that drainage boards had virtually power to fix any assessment that might appear reasonable, but we were unable to agree as to the reasonableness of their claim.

At the moment negotiations are being conducted between the Conjoint Conference and the Catchment Boards Association, and until such time as a national agreement is reached your Committee have advised members by circular that agreement should be given only to provisional assessments. In those cases where assessments have been made the companies concerned are requested to notify your Association of the basis thereof.

(*g*) *Metropolitan Rating and Assessments.*—The increasing importance of Rating matters and methods of assessing properties within the Metropolitan Area was engaging the attention of the Conference at this time.

The practice in the Metropolis was quite different from that without such area, and two meetings of the various London public utilities were held at which we were represented by Major R. N. Barnett (Chief Accountant of the South Metropolitan Gas Company) and the Secretary.

After mature consideration the Rating Committee had submitted their views embodied in certain resolutions to the Conference for their attention in the immediate future.

Income-Tax.

(*a*) *Public Lamps Rendered Obsolete.*—It appeared to your Income-Tax Sub-Committee that considerable injustice was being or likely to be done to member companies in view of certain matters that had arisen since the agreed scheme for determining income-tax allowances had been negotiated and could not at that time have been foreseen.

This Sub-Committee therefore made a recommendation to your Committee that representatives of the National Gas Council and this Association should collaborate in the pursuit of a claim for an allowance in all cases where public lamps were displaced or rendered obsolete by the change-over from gas to electricity.

Included in such recommendation was also a claim in respect of service mains, services and appliances rendered obsolete by any slum clearance schemes that Local Authorities had in contemplation.

As I have previously mentioned in my remarks on the Housing Bill, a compensation clause was inserted whereby Undertakings were covered in cases where apparatus was rendered obsolete. The latter part of such recommendation did not therefore arise, and it was not necessary to pursue the matter further.

(*b*) (1) *Depreciation Allowances under Agreed Scheme for All-Enamelled Cookers.*—Your Sub-Committee were of the unanimous opinion that joint action should be taken with the National Gas Council with the object of obtaining an increase in the present rate of allowances under the Agreed Scheme for apparatus. Foremost in the mind of the Committee were the new enamelled cookers, the design and colouring of which varied so much in these days when modern kitchens were arranged and planned to an extent hitherto unknown.

It was felt by your Committee that we might have a good case for a revision of the Scheme and that it was eminently desirable that the fullest collaboration should exist between the National Gas Council and ourselves to settle the proposed action. Up to the present two meetings have been held between representatives of the Council and our Sub-Committee, and evidence is in course of being procured from a number of the larger members of both organizations. When this is collated and agreed we shall be in a position (if thought desirable) to approach the Board of Inland Revenue as a body representative of almost all the company undertakings in the Industry.

(2) In view of the possibility that certain of our members might benefit through having their attention drawn to the fact and the details thereof, your Sub-Committee recommended that a circular should be prepared and sent to all members pointing out a recent ruling of the Inland Revenue as to the effect of the increased one-tenth allowance under Section 18 of the Finance Act, 1932.

The benefit of the new position is available to members who have adopted the agreed scheme. By this Act depreciation allowances were increased by 10%, the authorities did not accept our contention that this additional depreciation should not be brought into account in determining the written-down value from year to year under the scheme. Now, however, instructions have been given to tax inspectors to accept such contention, which will have a retrospective effect to the date when the Act came into force. The first year will be that of 1933-34.

(*c*) *Obsolescence*—Our Income-Tax Sub-Committee has been very active during the past year, and the most important matter in point of amount involved was one in which the facts, simply stated, were that a certain company had completely demolished an old retort house and retorts and replaced the same by an entirely new building. The Company contended that the claim should include the cost of the new building and the demolition of the old.

In another case an allowance had been refused in respect of a boiler house chimney although an allowance had been granted for the boiler, the reason being that the chimney was a building and not plant. Cases arise on occasion where the precise definition of the word "plant" is of some importance, and we intend to attempt to try to clear up the difficulty should a suitable occasion present itself.

In a third case an attempt to obtain relief in respect of Legal Costs arising on the renewal of a lease and to treat them as forming a part of the company's annual expenditure instead of a non-recurring expenditure to which a capital value attached was unsuccessful.

A great deal of work was involved in the negotiations with the Inland Revenue Authorities on these cases, involving an interview with the Chief Inspector of Taxes at Somerset House, the obtaining of the full facts in issue and attendant matters.

We are greatly indebted to the Sub-Committee for their patient work in these difficult cases.

Development (Loan Guarantees and Grants) Act, 1929.

Since last year the position under this head has improved a great deal. You will remember that those of us who had received grants from the Treasury were being pressed to pay income-tax on the ground that the grant was a "trade receipt."

I am pleased to inform you that the two cases selected in order to test the liability to tax were heard before the Special Commissioners, who decided that such grants were not liable to income-tax and that the cases were already covered by the House of Lords decision in the case of Crook *v.* the Seaham Dock and Harbour Board.

The latest position was that the Crown had decided to appeal against this decision but the Industry was prepared to meet any step in such an event.

Miscellaneous Matters.

Unstamped Meter.—An interesting case arose during the year. The Ashton Gas Company were summoned at the instance of the Board of Trade for supplying gas by means of a meter which, it was alleged, was not stamped as provided by the Gas Regulation Act, 1920, and the Gas Meter Regulations, 1920.

The case was contested by the Company before the Justices with complete success, despite the contentions of the Board of Trade who later, through their legal advisers, intimated their intention of appealing. You will be glad to know that the Board decided to abandon such intention.

Imperial Chemical Industries.—In the course of the past year certain companies both in England and Scotland while in the course of seeking Gas Special Orders had been met with objections made on behalf of Imperial Chemical Industries.

This large combination took exception to certain clauses in these Special Orders that had previously been incorporated as a matter of course, irrespective of whether that Company or any of its subsidiaries had works in the area covered by the Order or not.

Their objections were against the present right of undertakers to enter industrial premises to cut off supplies and against the granting to undertakers of the right to acquire, hold, and use any patent rights and licences; and the reasons for such objections were based on the fact that Orders with such Clauses were quoted against them as precedents which made it difficult for them to sustain their

objections to Orders in areas where they had a direct interest.

They contended that they had no other option, therefore, but to object to all Orders which included such clauses. I need not stress the seriousness of the position should such opposition gain ground; but I am assured that their opposition will be of no avail in those cases where that Company has no interest, but where they are concerned the issue will have to be contested if need be.

Electricity (Supply) Bill, 1934.—In order to appreciate the consequences of this Bill it is necessary to go back to the Electricity (Supply) Act of 1926.

The fundamental principles underlying that Act were that the Central Electricity Board should give supplies solely and exclusively to authorized undertakers and not act as a retailer of electricity supplies. In addition, the price to be charged was based on a tariff designed to ensure that the rates should be economic.

The main project of this new Bill fathered by the Government was to enable the Board to make direct supplies to railway companies and legalize the supplying of undertakers at rates less than the stipulated tariff.

You will appreciate that there was here a definite breach of principle and our Industry was concerned at the precedent involved. Despite determined opposition, however, the Government seemed bent on forcing the measure into the Statute Book, and it became law on Feb. 12, 1935.

Calor Gas.—This, as many of you well know, is a light hydrocarbon-butane mixture liquid gas, and as those who have been in America will tell you this gas was becoming a competitor of some moment to the Gas Supply Industry there. It seems that a great development will most probably take place, and our members would do well to take such steps as would enable them to handle the product. The matter is perhaps a little complicated at the moment, and each individual will have to consider whether his Company could under its Acts or Orders carry on such a business outside its Statutory area and so on. The National Associations will also need to determine so far as they can certain prominent difficulties, as, for example, would such gas (*a*) be subject to statutory requirements as to test? (*b*) be excluded from calculation in the cases of sliding scale and basic price Companies?

From what I have said you see the immediate difficulties, but that should be no reason for any failure on our part to move at the appropriate opportunity.

Changes in Committee.

The year 1935 has brought with it several changes in the ranks of our Committee; the retirement of Mr. Stokes was a great loss after a long period of redoubtable service among us, and on behalf of your Committee I desire to express our very sincere appreciation of the excellent services which he has rendered. On your behalf I welcomed Mr. F. G. Brewer, of the South Metropolitan Gas Company, as his successor.

Owing to the retirement of Mr. W. S. Morland from the Gloucester Gas Light Company since Sept. 30 he relinquishes his seat on the Committee after eleven years' valuable service, for which I desire to express our very real appreciation. To fill this vacancy a cordial invitation has been given to Mr. H. E. Bloor to join us again. Since his voluntary resignation in favour of Mr. R. Halkett we have much missed his assistance as a member of the Committee.

It is a matter of regret that I have to record the resignation of the Hon. Auditors to this Association, Messrs. W. A. Scott & Co., after a continuous connection with us of 23 years in that capacity. During that time much hard work was put in by that firm, and I wish to place on record our full appreciation of all they have done for us both inside and outside of the Association.

You will be requested to support the election of Mr. Hyde Burton as Hon. Auditor. My attention has been drawn on several occasions to the meticulous care with which our accounts are drawn up and the ease with which an auditor can satisfy himself thereon. This, I understand, is due in no small measure to Mr. J. B. Twycross (a member of Mr. Cooper's staff), whose good work could not pass without mention.

Secretary's Appointment.

In November last Mr. R. Girdlestone Cooper was appointed our Secretary. He had been Acting-Secretary since the death of his father in 1932; during that time Mr. Cooper had given us excellent service in his temporary capacity, and I feel that we can rest assured that his part of our work will be carried out with that care and attention we have always experienced from Mr. Cooper's father and himself.

An increasing number of matters arose during the past year when individual advice and assistance was sought from the Committee and Officers, several of which are briefly referred to in the Report.

The duties undertaken by the members of your Committee continue to be of inestimable value to us and the undertakings we represent. It is not only within the scope of our own Association but beyond its bounds where our representatives concede their time and energy in grappling with the frequent problems that arise, and must, in these days of continual progress, continue to arise.

We are represented on many bodies by colleagues to whom we owe our grateful thanks and appreciation for the sterling service they give us and the heavy responsibilities they so cheerfully assume; for what they have done for us I say, on your and my own behalf, "Thank you."

This is our 38th Annual Meeting. We are growing older, and I feel I can say that never during our 38 years of existence—years during which civilization was more than once rocked to its very foundations—have we been so preoccupied in safeguarding our interests and paving the way for expansion in the future of that Industry to which we have devoted our faculties.

My confidence in your representatives is absolute, and I know of no more pleasurable occasion than when we meet about your business. They do most assuredly deserve the confidence we repose in them.

I now formally move that the Committees' Report and the Accounts for the year ended Sept. 30, 1935, be approved and adopted and that the Report be entered in the Minutes.

The resolution for the adoption of the Report and Accounts was seconded by Mr. F. J. BRADFIELD (Vice-Chairman) and carried unanimously.

Re-Election of President.

On the proposition of the CHAIRMAN, seconded by Mr. C. F. BOTLEY, Dr. C. C. Carpenter, C.B.E., was unanimously re-elected President of the Association.

On the proposition of the CHAIRMAN, seconded by the VICE-CHAIRMAN, Messrs. R. Bruce Anderson, Reginald G. Clarry, M.P., A. A. Johnston, and Frank H. Jones were unanimously re-elected as Vice-Presidents, and the Secretary was instructed to write to Mr. Clarry, congratulating him on his re-election to Parliament.

The following members of the Committee retiring under Rule 12, and being eligible, were re-elected: Dr. C. C. Carpenter, C.B.E., Mr. F. J. Bradfield, Sir John Ferguson Bell, J.P., Mr. C. F. Botley, Mr. F. G. Brewer, and Mr. W. E. Caton.

In the place of Messrs. W. A. Scott & Co., the Association's Hon. Auditors, who had retired, the CHAIRMAN proposed the election of Mr. Hyde C. Burton, F.C.A., who had stated that he would prefer to accept this appointment in an honorary capacity, and Mr. Burton was unanimously elected.

Mr. E. J. K. FUSSELL thereafter proposed a hearty vote of thanks to Mr. Edwards for presiding over the meeting and for the able manner in which he had dealt with so many matters which affected the Gas Industry as a whole and their Association in particular. He had covered the whole of the ground, and Mr. Fussell expressed the hope that every member of the Association would read his remarks, because it would help in driving home to them the usefulness of the Association and would form a permanent record of the difficulties which they had to face and of how they dealt with them. He was sure that if members read it they would fully appreciate that when they joined this Association it must result in great benefit to themselves and the Industry as a whole. He wished they could send a copy of the report to every gas company in the Kingdom, because, if they did, he was sure that the Association would certainly increase its membership. He congratulated Mr. Edwards and remarked how fortunate they were in having him to preside over them.

Mr. J. B. BROWN (Wandsworth), in seconding the vote of thanks, observed that the work of the Association during the past year had been vast, and it was due very largely to the way in which members had been able to draw upon Mr. Edwards's valuable time and experience as well as that of the Sub-Committees. He took this opportunity of congratulating the Chairman upon the valuable work which had been done through the Association for the benefit of the whole Industry.

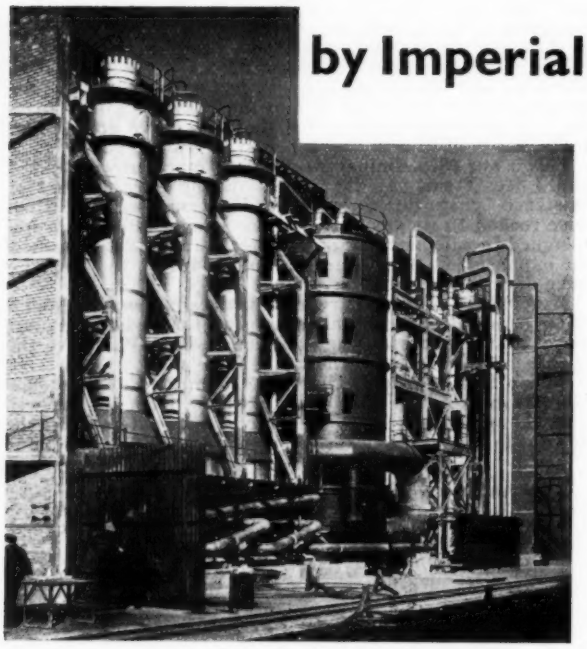
The CHAIRMAN, in acknowledging the vote of thanks, remarked that he had now been associated with the Committee for 22 years, and he greatly appreciated the very kind way in which they had referred to what little he was able to do. What he did, however, would be of small moment were it not for the full co-operation which he received at all times from the rest of the Committee.

The Development of Coal Hydrogenation by Imperial Chemical Industries, Ltd.

by

KENNETH GORDON

From a Paper presented to the members of the Institute of Fuel at a Meeting in London on Friday, Nov. 22.



High-Pressure Vessels, termed "Converters," where the Coal is Hydrogenated.

We owe to Bergius the conception of the hydrogenation of coal to give oil. His experiments started before the War, and ended with a small technical plant at Rheinau, near Mannheim, which was in operation until 1927.

After the War, the I.G. Farbenindustrie started work independently and brought to bear on the problem their great knowledge of high pressure technique and of catalysts. They made two important advances—the discovery of catalysts immune to sulphur poisoning and the division of the hydrogenation process into liquid and vapour phase stages.

Developments in Germany then passed wholly into their hands and they built the first commercial hydrogenation plant at Leuna in 1927. This was designed to produce 100,000 tons per year of petrol from brown coal, but at first it was operated mostly on low-temperature tar made from brown coal and on German crude petroleum. Experimental work was also done with bituminous coal. The applicability of the process to the petroleum industry was soon recognized and a joint Company for its exploitation was formed by the I.G. and the Standard Oil Company (New Jersey). Two plants were built by the Standard Oil Company in America which have been used for the production of petrol, special solvents, lubricating oils, and kerosene.

In the meanwhile, the original Bergius process had been considered for British conditions, and tests on British coals were made at Rheinau. The I.C.I. decided that this process, worked in the original way to give a variety of products—petrol, tar acids, heavy oil, and pitch—was not profitable, but that it was more attractive if it could be modified to produce only petrol. It was decided also that the process must start with bituminous coal itself since it was unlikely that tar, whether from low or high temperature carbonization, would ever be available in sufficient quantities to make any large proportion of the country's oil supply.

Experimental work at Billingham started early in 1927, and in 1929 it was decided to build a pilot plant to treat 10 tons per day of coal. This plant was started up later in the same year, and ran until the end of 1931. It was the first plant to hydrogenate bituminous coal on the scale of a commercial sized unit for any prolonged period. Although, as was natural, many difficulties were found, none proved insuperable.

In 1930, the I.C.I. announced that they could produce a 60% weight yield of petrol from coal, and they gave estimated costs, showing that commercial development was possible only with Government assistance. Although many experts denied the possibility of such a large yield, the facts were satisfactorily demonstrated to officials of the Fuel Research Station delegated by the Government to enquire into the matter.

As the process developed, the I.C.I. realized that although the original Bergius patents had lapsed there were many important patents held by the Standard-I.G. group. Discussions were opened with this group, as a result of which in 1931 the four major operators in the field—namely, the I.G. of Germany, the Standard Oil Company (New Jersey), the Royal-Dutch-Shell group, and the I.C.I., associated themselves in a pooling Company, the International Hydrogenation Patents Company, in order to pool their patent rights and to effect a general exchange of technical information, the I.C.I.'s interests being centred in the British Empire. At the same time arrangements were made for marketing products through existing oil distributing Companies.

This pooling of technical resources on an altogether unprecedented scale has been uniformly beneficial, and the I.H.P. group is now pre-eminent technically and their patent position very strong. Even apart from the patent position it would seem imprudent to attempt to operate independently when there are available such great accumulated practical experience and technical resources as are possessed by the constituent Companies in the I.H.P. pool.

In 1931, the I.G. resumed the hydrogenation of brown coal on a large scale, and this now provides the major part of the output of the hydrogenation plants in Germany. During 1932, the I.C.I. concentrated their hydrogenation research work on the treatment of bituminous coal, and were able to make several great advances in technique; at the end of the year schemes were prepared for building a large hydrogenation plant at Billingham.

In July, 1933, the Government announced their intention to guarantee the continuance of the preference on light oils made from indigenous materials for a period of years, by means of the British Hydrocarbon Oils Production Bill. This enabled the Directors of the I.C.I. to decide to proceed with the erection of a plant at Billingham. The plant was to be ready early in 1935. Later it was agreed to take advantage to the extreme limit of the facilities available at Billingham and thus to increase the output of the plant by some 50%. Tar oils, if available at a suitable price, were to be used as the raw material for this additional output, partly with a view to promoting the interest in hydrogenation of the carbonizing industries and securing their co-operation, partly to minimize the capital cost, and partly because it was not desired to increase commitments on the then relatively untried process of coal hydrogenation.

In 1934, a large-scale experiment was carried out by the I.G. at Ludwigshafen on the hydrogenation of bituminous coal. The plant was operated for four months, and it was found that the process ran quite smoothly and successfully.

A large-scale plant at the Hibernia Colliery in the Ruhr is now decided on, to produce about 125,000 tons per year of petrol from bituminous coal. The hydrogenation plant

at Leuna is extended to 325,000 tons per year output mainly by direct hydrogenation of brown coal, and two more plants are being erected in Germany, each of about 150,000 tons per year of petrol output.

I.C.I. Development and Research.

The interest in hydrogenation of the Department of Scientific and Industrial Research, and in particular of the Fuel Research Board at Greenwich, is well known. Credit is due to their early official recognition of the potential importance of the process to this country.

In 1927, I.C.I. acquired the British Bergius Syndicate and started independent research on the process. In 1930, they disclosed to the Fuel Research Board full details of the progress they had achieved.

Since then, the Fuel Research Board has continued its work and published many papers on its experiments. The I.C.I. have also continued their researches, but, as stated by Sir Harry McGowan in his recent speech at Billingham, on a greatly enlarged scale and at a heavy annual cost. Since 1931, by reason of the arrangements with the International Hydrogenation Patents Company, we have published very few details of our work in the scientific literature. Its volume may, however, be realized from the fact that between 1927 and 1933 our expenditure on hydrogenation, including the construction and operation of a 10-ton a day pilot plant, amounted approximately to £1,000,000.

Apart from the fundamental discovery of coal hydrogenation, due to Dr. Bergius, the construction and operation of the present plant at Billingham is the development solely of our own research and experience, amplified by the research and experience of our associates in the International Hydrogenation Patents Company.

The first experimental equipment installed at Billingham was of the type used by Bergius, which has been studiously copied by subsequent investigators. It is a small pressure autoclave working on the batch principle and heated externally by gas. In such apparatus the chemistry of the reaction was studied and numerous catalysts were tried.

The pilot plant built by Bergius used stirred, externally heated, horizontal converters. Theoretical considerations led us to regard external heating on a large scale plant as unnecessary because of the exothermicity of the reaction. We also thought that by using a vertical reaction vessel of suitable shape, the stirring action of the hydrogen would enable mechanical stirring to be dispensed with.

A small scale plant was built to test these principles, and in 1928 success was achieved. Three or four of these continuously operating coal hydrogenation plants have been working at Billingham ever since. Various sizes of reaction vessels have been employed, that now used being 20 ft. high and 4 in. in diameter. Although these experiments proved that on the large scale heating is unnecessary, on a small scale heat losses are so disproportionately severe that external heating must be applied. The converters must be made of special steel to withstand hydrogen attack.

The second part of the research programme was the investigation of catalysts.

In 1929, we found that the most promising catalyst for the hydrogenation of bituminous coal was the element tin. We first intended to use it in the form of tinned iron plates, arranged as a grid. This arrangement, although practicable, was rapidly discarded in favour of a continuous injection of a very small amount of certain organic compounds of tin.

Immediately after this very important discovery, it was decided to erect a pilot plant at Billingham to hydrogenate 10 tons per day of bituminous coal.

The erection of this plant was started early in 1929, it was in operation at the end of the year, and was run until 1931. The converter employed was of ingenious design, contrived to use the technique developed for ammonia synthesis. The coal paste and hydrogen were heated separately, an electric heater being used for raising the hydrogen to its final temperature. The heat exchangers were of the coiled double tube type. The internal parts were all made of mild steel, for although it was known that this would be attacked by hydrogen and by sulphur, it was considered that expenditure on more expensive materials was not justified until the design was more developed.

The design incorporated a feature which has been characteristic of Billingham practice—that is, the reaction vessel itself does not have to withstand the mechanical stresses due to pressure, and is separated from the pressure resisting walls by a layer of heat insulating material. The inner vessel therefore withstands the temperature and not the pressure, and the outer wall the pressure and not the temperature. This makes the use of expensive materials for the converter forgings unnecessary.

The plant was found to have a capacity of 15 tons per day of coal, making petrol of good quality. The middle oil was stored and the heavier oil disposed of by recirculating it with coal. The treatment of the middle oil—that is, the fraction boiling between about 170° and 300° C.—at first presented some difficulties. The oil is so aromatic that it yields a very small quantity of lighter spirit upon cracking. The solution of the problem was found in vapour phase hydrogenation, and a satisfactory plant for this process was built at Billingham, and worked in 1931. The design of this plant was similar to the coal hydrogenation plant.

In 1931, the I.H.P. Agreement made it possible to compare our results with those achieved by the I.G. in Germany and the Standard Oil Company in America.

We found that the I.G. had at first used converters not unlike those employed at Billingham, which had been replaced by simpler and larger units. The converters consist of cylindrical vessels with internal heat insulation. The heat exchangers are of the multitube type, contained in separate forgings. The appropriate number of converter and heat exchanger units are connected in series. The final heating is done by passing the hydrogen and oil simultaneously through tubes in a gas fired furnace. This type of plant requires special chrome steels to withstand the action of hydrogen at pressure and at high temperatures.

In order to test the suitability of the I.G.'s type of plant for British coal, a few hundred tons were shipped to Ludwigshafen and a successful experiment was staged there on much the same scale as the original plant at Billingham.

The Billingham pilot hydrogenation plant was closed down at the end of 1931, but research work continued in the laboratories. In 1932 we made further important discoveries concerning the hydrogenation of coal. It was found that the range of coals which could be successfully hydrogenated was much increased by the use of coal cleaning, combined with the use of hydrogen chloride in the reaction vessel.

Coal cleaning is beneficial not only for the obvious reason that it avoids expensive processing of coal ash, but also because the ash is usually alkaline and has a deleterious effect on catalysis. Hydrogen chloride—added as such or as a compound which forms it under reaction conditions—neutralizes the residual ash, and a further quantity has a beneficial effect on the hydrogenation reaction itself. Full benefit of this discovery could not be made until we discovered a method for neutralizing the hydrogen chloride in the vapours leaving the converter before cooling. Even before hydrogen chloride was added deliberately, we were troubled by corrosion in the heat exchangers and coolers after the converters, due to the condensation of hydrochloric acid. Further, the tubes were liable to become choked through deposits of ammonium chloride and ammonium carbonate.

In 1933 we found and patented a process for making a stable suspension of alkali in oil, and for freeing the hot vapours at 450° C. from acidic constituents by scrubbing them with it. This permitted the use of relatively high concentrations of hydrogen chloride in the reaction space, since the corrosion at reaction temperature is negligible. These two inventions, the use of chlorine and tin compounds as catalysts, and the neutralization of the vapours with alkaline paste, put the hydrogenation of bituminous coal on an absolutely sound practical basis.

A further change decided upon as a result of our research work was to divide the process into three stages. The primary hydrogenation of coal gives gas, petrol, middle oil, and heavy oil. It is possible to control the reaction conditions so that there is neither a loss nor gain of heavy oil, and the production is exactly enough to make coal into a paste for reintroduction into the converter. This gives a simple plant arrangement, but has the drawback that coal and heavy oil are being hydrogenated under identical conditions, which cannot be best for both reactions.

We decided, therefore, to operate with reduced reaction volume so as to give a surplus of heavy oil. The heavy oil is then treated separately under more suitable conditions than those existing during the hydrogenation of coal, and the overall yield is thus increased.

This method of operation is only desirable in units of the largest size. In smaller plants, the small decrease in yield due to two stage operation is more than compensated for by lower capital and operation costs due to greater simplicity.

In spite of the progress we have made, work in the laboratories is still continuing and doubtless will do so for many years. Owing to the congestion of the laboratories at Billingham, it was decided last year to erect new buildings which are to be devoted to coal hydrogenation entirely.

Large Scale Development at Billingham.

At the end of 1932, the research programme which had been carried out after the signing of the I.H.P. Agreement had reached fruition. Vastly improved designs were available, based on our own experience allied with that of our associates in the I.H.P.

Special facilities existed at Billingham which enabled us to put forward an estimate for a plant to manufacture 100,000 tons per year of petrol from coal at a capital cost of £2,500,000. Immediately the British Hydrocarbon Oils Production Bill was announced in July, 1933, the I.C.I. stated that they had sanctioned the building of this plant. As the scheme developed, it became apparent that the output could be increased over the originally decided figure. Further improvements in catalysts gave us some reserve capacity in the liquid and vapour phase sections of the hydrogenation plant. It was therefore decided to increase the plant capacity by tar hydrogenation. The necessary additions to the plant for the reception, storage, and distillation of creosote oil and low-temperature tar were decided on, and the capacity of the plant brought up to 150,000 tons per year of petrol. This increased the capital requirement to £3,000,000. The value of the existing plant used is £2,500,000, making a total of £5,500,000. This is substantially more than would be required for an entirely new plant of similar output.

Contracts have been made with tar distillers for the supply of creosote oil, and with low-temperature carbonization interests for the supply of low-temperature tar.

Of our total flowsheet output of 150,000 tons per year, approximately 10,000 tons is derived from low-temperature tar, 40,000 tons from creosote oil, and 100,000 tons from coal. Should the price of tar products increase so that it is no longer profitable to utilize them for hydrogenation, the output will be made entirely from coal by small adjustments to the plant.

The hydrogenation of tar products in a plant primarily designed for coal hydrogenation has both technical and economic advantages. Tars are very conveniently processed by using them to make up the coal paste; troubles due to the presence of solids, to instability, and to the corrosive properties of tar, are thus eliminated. The size of plant enables operating costs to be lower, and the credits for tar therefore much higher than would be the case for a plant using tar only. As we have said, the flexibility of the plant enables the quantity of tars consumed to be adjusted according to their market price.

The building of the plant at Billingham involved a very large increase in the staff and labour and made severe demands upon the workshops, drawing office, and similar facilities at Billingham. The staff and labour rose from an average of 7,000 in early 1932 to 13,600 at the peak of the construction period, and is now 9,500. The present increase due to petrol production is about 2,000, which includes all hydrogen production, services, repairs and alterations, research and administration. This number will probably be reduced when steady running is achieved and is substantially greater than would be necessary for an independent works not undertaking such a heavy research programme as Billingham and making most of its hydrogen from hydrocarbon gases instead of from coke. The capacity of the workshops at Billingham, where all our high-pressure valves and other fittings are made, was increased by operating them continuously on shift. Four-shift operation, giving an average of 42 working hours per week, was employed in the workshops with mutual satisfaction to ourselves and to the men. It was decided to add a new shop for handling heavy tubes. For the petrol plant very large numbers of very heavy high pressure tubes, frequently in alloy steel, had to be cut, bent, and machined, and it was also decided to employ welding to an extent hitherto unprecedented in high pressure work. This tube shop, as it is called, complete with its butt resistance welding machine and annealing furnace, was put into operation only 26 weeks after starting on the programme. The first plant building to be finished was the maintenance building where the heavy forgings are assembled. The first converter forging was delivered here in April, 1934.

It was decided to complete the vapour phase converters first and operate them on a light distillate oil made from creosote oil. Liquid phase converters were next to be started with the heavy residues from creosote oil, and lastly the coal hydrogenation units themselves. In this way, the operation of coal hydrogenation units, when they were once going, would not be interrupted by failure or difficulties in subsequent parts of the process.

Storage facilities were sufficiently advanced to receive the first consignment of creosote oil in August, 1934. The creosote distillation unit was started up in November, 1934. Sections of the plant were put up to pressure with hydrogen in January, 1935, and the first vapour phase hydrogenation unit was sufficiently advanced to permit of lighting the burners of the preheater in the same month, 17 months after sanctioning expenditure on the plant.

Oil was first injected for hydrogenation on Feb. 7, and production has continued without interruption from that time. The first coal hydrogenation units were ready for operation at the beginning of April, but it was decided to make some alterations to avoid certain difficulties which had been experienced in starting the liquid phase hydrogenation unit.

Coal was injected for the first time in June, and since then the output has steadily increased in spite of interruptions from time to time to make minor modifications of the sort usually required in a new plant. We expect to attain full flowsheet output before the end of this year.

The stock position was by the beginning of April sufficiently secure to commence regular shipment of finished petrol to the oil companies, and the first boat left on April 9. From that time shipments have been made regularly.

Most despatches have been made by water, and the petrol is taken away in tankers of 1,000 tons capacity from the special jetty built for the purpose at Billingham.

The plant at Billingham is deliberately laid out so as to provide the maximum flexibility for additions and alterations. When the whole plant has run long enough to determine the various limitations to output, these will be eradicated step by step, and doubtless the Billingham plant will finally have an output considerably in excess of the present one.

The hydrogen supply is derived from coal via coke and the water-gas process.

The hydrocarbon gases formed as a by-product consist of methane, ethane, propane, and butane. They are now burned under the boilers, so that although they are not wasted the most economic use is not made of them. A plant is being erected at Billingham for the manufacture of hydrogen from these gases by treatment with steam in the presence of catalysts. This process was worked out originally by the I.G. and the Standard Oil Company. It provides the latter with the hydrogen for their hydrogenation plant in America. The Billingham unit will be ready early next year, and all future extensions and other plants built for hydrogenation will probably obtain the major part of their hydrogen requirements from similar units.

These hydrocarbon gases give us in this country a supply equivalent to the natural gas of America and other countries with oil fields. Part of this gas is already in commercial use. The butane is separated, liquefied, and bottled and sold to the Calor Gas Distributing Company, who are developing the use of butane for domestic purposes in places where coal gas is not available.

Phenol, cresol, and high homologues are available in substantial quantities in the crude product from coal, but are not yet worked up.

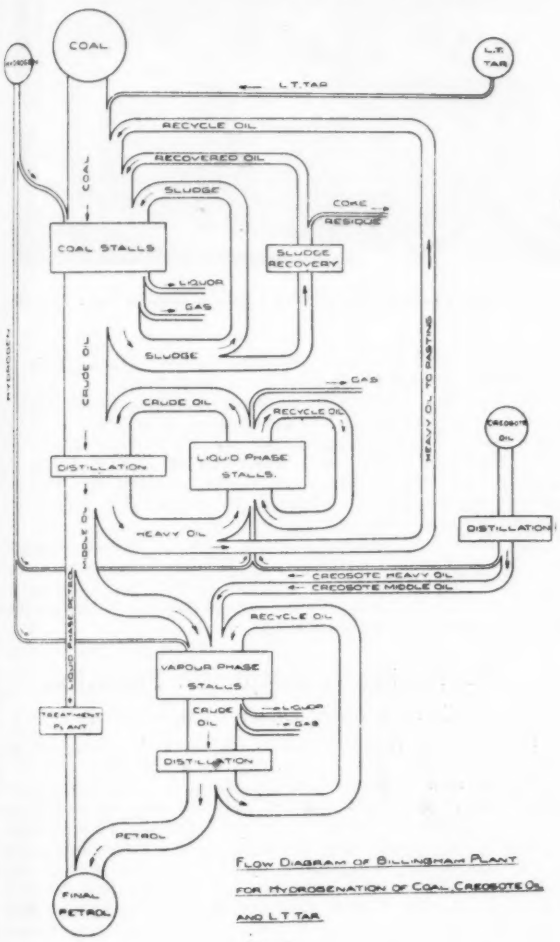
Description of the Billingham Petrol Plant.

For the hydrogen producing process used at Billingham the coke is made in coke ovens and transferred directly to the water-gas plant. The water gas is purified from sulphur and treated with steam in the presence of a catalyst to give catalyzed gas, which is a mixture of hydrogen, carbon dioxide, and a small amount of carbon monoxide. This gas is compressed and purified from carbon dioxide by scrubbing with water at 50 atmospheres pressure, and from carbon monoxide by scrubbing with copper solution at 250 atmospheres pressure. The gas flows through duplicate high-pressure mains to the petrol plant, where it enters the suction of the circulating machines. These are designed to operate with 230 atmospheres suction pressure and 263 atmospheres delivery pressure. The circulating hydrogen becomes impure partly through accumulation of nitrogen from the make-up gas, and partly through accumulation of methane, ethane, propane, and butane formed in the process. Part of these gases is removed by solution in the products themselves, and is recovered upon release of pressure. The purity of the circulating gas is finally controlled by scrubbing with oil at full pressure. The hydrocarbon gases readily dissolve in oil, and are recovered upon release of pressure. Fortunately, nitrogen is more soluble than hydrogen in oil, and thus is similarly removed from the system.

The general flowsheet of the process as worked at Billingham is shown in fig. 1. It will be seen that low temperature tar is used as part of the pasting oil. The creosote oil is distilled, and the heavy fraction hydrogenated in the liquid phase, while the light fraction passes directly to the vapour phase. It is possible that later we will use the whole of the creosote oil as pasting oil, since it is apt to contain traces of impurities which give trouble in the vapour phase part of the plant.

The Chance process is used for providing the clean coal

required at Billingham. This process depends for its action on floating the raw coal on a suspension of sand in water. It is necessary first of all to remove all dust and fine particles of coal, which is effected by air elutriation, followed by screening. The subsequent sand and water flotation process is arranged to operate in two stages. First the coal is separated into refuse of low carbon content and a moderately clean coal of about 7% ash content. This partly clean coal then passes to the second stage where separation is made into clean coal with not more than 2½% ash and middlings with 15% ash. The coal-cleaning plant is built adjacent to the boiler installation at Billingham so as to use the coal handling facilities already installed there. The fines and middlings from the coal-cleaning plant pass directly by band conveyors into the main boiler plant, which is a powdered fuel installation. The clean coal is taken by truck to the hydrogenation plant where it is stored in bunkers which contain two days' supply.



FLOW DIAGRAM OF BILLINGHAM PLANT FOR HYDROGENATION OF COAL, CREOSOTE OIL AND L.T. TAR

Fig. 1.

The clean coal passes to the grinding mills via weighing machines which are contrived to deliver coal, pasting oil and catalyst in the required proportions. These are fed simultaneously into the grinding mills which both grind up the coal and mix it with pasting oil. The coal "paste" contains 50% coal, and is quite fluid and reasonably stable.

The injectors for delivery of coal paste against the required pressure of 250 atmospheres are, in accordance with previous practice, hydraulically operated. The water for power purposes is supplied from centrifugal pumps delivering at 40 atmospheres pressure.

The coal paste then passes to the coal hydrogenation units which are similar in design to the other units used for heavy oil and vapour phase hydrogenation. The coal paste and hydrogen are mixed together and are heated up to reaction temperature first in heat exchangers, and secondly in gas-fired preheaters. The coal, oil, and hydrogen then pass together through the converters in series. On leaving the last converter, the gases and vapours are separated from the residual heavy oil which contains the ash and unconverted coal. The heavy residual oil is let down in pressure separately, part of it is used for making up the coal paste and part treated for recovery of oil and solid coke. The gases and vaporized oils go to the heat exchangers and coolers. The liquid oils are separated under pressure, and the gases go back to the circulators, after washing out any excess hydrocarbon gases in the gas-washing plant.

The converters, heat exchangers, and preheaters of all the units are arranged in one line on heavily piled foundations. In each stall, as each unit is called, the converters, heat interchangers, and interconnecting piping, which are at elevated temperatures, are separated from the rest of the plant by a high brick wall which acts as a screen in the event of fire. This wall is on the west side of the plant which is open to the east. This is very convenient for maintenance work, but access is not otherwise permitted to the space in front of the operating stalls.

Each pair of stalls has a roomy control room which contains all the instruments and all valves required during ordinary running. From the control room it is possible not only to carry out the ordinary running of the stall but also in case of emergency to isolate the unit from the rest of the plant and to blow down the pressure to vessels ready kept filled with carbon dioxide against this contingency. This arrangement of control rooms is extremely convenient and also affords a high degree of safety to the operatives.

The crude products from the hydrogenation plant are released in pressure at the control room and travel along high-pressure pipes to the let down stations.

The heavy oil let down from the hot separators is pumped from here partly back to the paste preparation plant, and partly to the sludge recovery plant, where it is separated into coke which is used up in the boilers, and oil which is returned for making up paste.

The light oil products from the cold separators are released in pressure in three stages. In this way the gas released by the removal of pressure is separated into a lean gas and a rich gas which must be treated for recovery of light fractions of petrol. The crude liquid product flows through meters into storage tanks in which the ammonia liquor settles out. Fig. 2 gives a general view of the plant and shows the storage tanks for intermediate products. The rich gas released from the final stages of pressure release is stored in a holder and compressed to 4½ atmospheres for recovery of petrol at the distillation plant.

The crude oil storage is considerable to enable the hydrogenation and distillation plants to be run as independently as possible. In the distillation plant we have the following units:

(1) Vacuum still for separation of creosote oil into middle oil and heavy oil.

(2) Vapour phase still and petrol stabilizer working at a pressure of 4½ atmospheres, separating vapour phase crude product into middle oil and stabilized vapour phase petrol.

(3) Liquid phase distillation unit, combined with petrol recovery plant. The crude liquid phase product is separated into stabilized petrol, naphtha, middle oil, and heavy oil. The unit also contains an absorber and stripper to separate the petrol from the compressed rich gas from the pressure release station. A butane unit is included. This plant works at the same pressure of 4½ atmospheres.

The distillation products pass into storage tanks which are of sufficient capacity to take care of routine shut downs of the distillation and hydrogenation units. All the petrol is immediately washed with caustic soda to remove H_2S. The petrol is stored under nitrogen.

The vapour phase petrol requires no refining after its soda wash. The liquid phase petrol goes to the treating plant, where it is washed with sulphuric acid and caustic soda and finally re-run. The finished petrol is pumped to the final storage tanks, which are about one mile distant from the hydrogenation plant site and adjoin a special loading jetty on the River Tees.

Efficiency of the Process.

The yield of petrol from coal calculated on an ash and moisture free basis is greater than the figure of 60% formerly published. We prefer, however, not to give any new figures until the plant has been in operation for a longer time than at present, and really accurate figures are available. The yield of petrol from tars and tar oils varies from 80-90% by weight.

The most important figure is the over-all coal consumption. On a new plant, in which the major part of the hydrogen requirements would be made by the methane steam process, we estimate that the over-all consumption of raw coal would vary from 3·5 to 4 tons per ton of petrol, the exact figure depending upon both the ash and moisture content of the coal, and its suitability for the process. The thermal efficiency is therefore 40% which compares favourably with 25% for generation of electric power, and 55% for gasification.

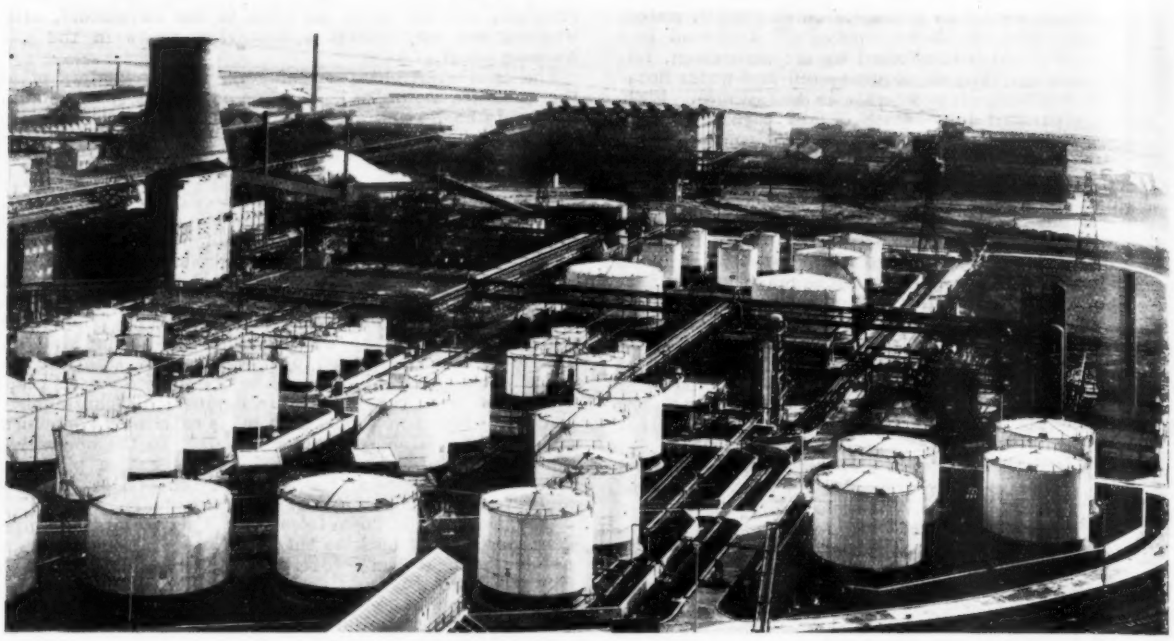


Fig. 2.—A "Tank Farm" for the Storage of Intermediate Oils and Finished Petrol. The Tanks are Finished with a Special Paint to Reflect the Heat

In the Billingham plant, the hydrogen is not made from hydrocarbon gases, but from coal via coke and water gas. The over-all raw coal consumption at Billingham for the 100,000 tons per year of petrol made from coal is 500,000 tons. This is 5 tons of raw coal per ton of petrol, and this higher figure is primarily due to the lower efficiency of coke ovens followed by water-gas generators compared with the catalytic manufacture of hydrogen from hydrocarbon gases, and is partly compensated for from the financial point of view by credits for the tar, benzole, and gas made as by-products. A further 100,000 tons per year of coal are used in making the hydrogen and power required for the hydrogenation of creosote oil and tar, so that the total additional coal consumption due to the petrol plant is 600,000 tons per year. The total coal consumption at Billingham, including that required for chemical manufacture, is between 1¼ and 1½ million tons per annum.

Quality of Product.

The following Table gives the essential properties of typical petrols made by the hydrogenation process. "1" refers to a petrol obtained directly from coal which corresponds to current specifications for No. 1 spirit. "2" indicates a vapour phase petrol made up to a typical Ethyl specification with load. "3" is a spirit made to comply with the Air Ministry's latest specification for spirit of 87 octane number.

Properties of Hydrogenation Petrols.

—	1.	2.	3.
Specific gravity	0·740–0·745	0·734–0·738	0·730
I.B.P.	35° C.	35° C.	35° C.
90% vol. recovered at	158° C.	160° C.	150° C.
F.B.P.	170° C.	170° C.	165° C.
Residue	1·0%	1·0%	1·0%
Loss	1·0 ,,	1·0 ,,	1·0 ,,
% distillation + loss—			
At 70° C.	20 ,,	19 ,,	21 ,,
At 100° C.	40 ,,	40 ,,	50 ,,
At 140° C.	75 ,,	75 ,,	87 ,,
Reid vap. pressure at 100° F.	9 lb. per sq.in.	9 lb. per sq.in.	7 lb. per sq.in.
Octane No. C.F.R. motor method	71–73	80	..
Octane No. C.F.R. aviation method	..	..	87
Colour	+ 25 Saybolt	Red	Blue
Odour	Marketable	Marketable	Marketable
Sulphur, % by weight	0·05	0·01–0·02	0·01–0·02
Doctor test	Negative	Negative	Negative
A.S.T.M. copper strip corrosion test	,,	,,	,,
Gum, pyrex dish without air jet (mgm./100 ml.)	2·0	up to 3·0	up to 3·0

The petrol made is of uniformly good quality, and does not give any special difficulty in refining. The very high volatility figures will be noted, since, although this characteristic is essential for modern motor fuels, it is not generally possessed by petrol made from coal.

In the last two years we have not had much time to give any attention to the problem of producing diesel oil from coal. In an earlier paper we described a reasonably good diesel oil. The only objection to this material was that it was rather lower in viscosity than the material commonly employed. There is no insuperable difficulty in producing a satisfactory oil.

The heavy oil obtained from coal is perfectly suitable for use as fuel oil without any further treatment. Fuel oil could be produced at a much lower cost than petrol. We have had no time to give any attention to the problem of lubricating oil manufacture.

Combating Atmospheric Pollution

New Measures Under Consideration

Thirty-eight representatives of local authorities and other organizations co-operating with the Department of Scientific and Industrial Research in the investigation of atmospheric pollution met recently in the half-yearly conference at the offices of the Department. The gathering included representatives from Barnsley, Dagenham, Glasgow, Halifax, Kingston-upon-Hull, Leamington Spa, Leicester, Liverpool, London, Manchester, Salford, Scarborough, Sheffield and Rotherham, Southampton, Westminster, Willesden, The British Commercial Gas Association, and Messrs. Cadbury Bros.

The Conference, over which Councillor Brownhill-Smith, M.V.O., D.L., of Glasgow, presided, received from Dr. G. M. B. Dobson, F.R.S., Chairman of the Atmospheric Pollution Research Committee, a Report on the progress of the researches carried out under the Committee. The Conference noted with interest the offers received from co-operating authorities to undertake additional investigations and observations (including observations in country districts). A report was presented by Mr. J. W. Beaumont, of Halifax, upon the analysis of atmospheric dust samples collected in Leeds, Halifax, and Huddersfield.

The representatives of the London County Council brought to the attention of the Conference the desirability of reviewing the measures which have been taken in this country and elsewhere to obviate the emission of soot, ash, grit, and gritty particles from chimneys such as those of electric power stations. Representatives of other local authorities emphasized the need of a wider investigation, which should include the consideration of remedial measures for combating pollution. After further discussion the Conference appointed a small Committee to meet the Department and thereafter to put forward for consideration concrete proposals for investigations to promote the application of remedial measures by industry and to devise a scheme for securing the financial co-operation of the various local authorities.

Does Hydrogenation Pay?

The Author considers the economics of the production of petrol from tars, and arrives at the conclusion that only protective government measures can keep such hydrogenation processes alive.

by

F. G. LAUPICHLER

Consulting Engineer for High-Pressure Technique, and specialist in the hydrogenation of oil and coal of Salzburg, Austria

The development of the hydrogenation process, culminating in the erection and starting in operation of a large-scale plant for the production of synthetic motor spirit from brown coal by the I.G. Farbenindustrie, Germany, and some plants for the refining of oils by the Standard-I.G., U.S.A., has now been followed by the starting to work of the first plant in the world for hydrogenation of bituminous coal by Imperial Chemical Industries, Ltd., at Billingham-on-Tees.

At the same time, a number of similar plants are either under construction or have been decided to be installed in many other countries. Thus, in Germany, apart from the Leuna Works of the I.G., the newly founded Braunkohle-Benzin A.G. has started erection of a hydrogenation plant at Böhlen; preparation is being made for installation of another at Magdeburg. In the Ruhr District a plant is to be erected by the Hydrierwerke Scholven A.G. for the manufacture of synthetic petrol from bituminous coal, and other schemes are being planned by Zeche Victor and the Ruhrchemie A.G., which latter has taken the initiative for the foundation of the Ruhr-Benzin A.G. for the production of motor spirit by the Fischer process.

In France two plants are under construction, fostered by the Office National des Combustibles Liquids, Paris; in Hungary two small plants are expected to start operation some time next year; in Russia a large plant is supposed to have commenced production a few months ago; and even Spain and Japan show considerable interest in the hydrogenation process.

Is it surprising that again the question of the economics of hydrogenation is being eagerly discussed? Owing to lack of real information in regard to the economics of the process, opinion in this direction is still widely divided. While optimists hold the view that hydrogenation has already proved to be a success just because such big and well-managed companies as the Standard Oil Company, I.C.I., and I.G. Farben " would take no risks," others consider hydrogenation a complete failure commercially.

To find a basis for discussing this question let us first consider the matter of the raw material used in hydrogenation works during past years and to be utilized in the future by the already established works and future schemes.

It is well known that at the first industrial plant of the I.G. Farben at Merseburg (Leuna Werke) it was originally intended to use brown coal as raw material, while very soon after having commenced operation merely tar and other liquid hydrocarbons were being employed. Although repeatedly it was stated that hydrogenation of coal should have reached the stage of final success, there is still only a small percentage of petrol produced by direct hydrogenation of coal—and this after having collected experiences over many years of operation with both liquid hydrocarbons and coal itself!

The next plant to start at Böhlen and the other schemes of the Braunkohle-Benzin A.G. are based entirely on brown-coal tar, although this makes it necessary to erect a new plant for the production of tar, the capacity of which is 200,000 tons per annum.

This certainly proves that, either technically or commercially, hydrogenation of coal is not considered to be more promising than that of liquid hydrocarbons. In this connection it is worth noting that I.C.I. has concluded a long-term contract with Low-Temperature Carbonisation, Ltd., for the supply of tar. At any rate, there is no doubt that hydrogenation of liquid hydrocarbons is at least practicable on a large scale, while even this will still have to be proved in regard to coal.

For this reason it would be premature to dwell upon the future economic aspect of the treatment of coal, and the economics of the process will here be discussed only in regard to liquid hydrocarbons as raw material—preferably tars of different origin.

As is well known, the same apparatus can be used for all sorts of raw material in a more or less liquid state, and with small modifications also for pulverized coal mixed with oil or tar.

By adjustment of the working conditions to obtain about the same yield of petrol for different liquid raw materials, merely the throughput will change, and for various sorts of liquid hydrocarbons this change will be but small, making it permissible to evaluate the approximate costs for any liquid hydrocarbon—suitable for hydrogenation—by varying but the price of the raw material in the calculation carried through for one fixed raw material.

In the following sections the calculations are carried out for the hydrogenation of brown-coal tar, as practised in Germany, and German economic conditions are considered only, as this country has up to the present most advanced in producing part of her demand for motor spirit by hydrogenation.

These conditions, however, are fixed in such a manner that it will be easily possible to evaluate from the following tables the production costs for synthetic petrol for different economic conditions in any country.

Capital Investment.

For the estimation of the capital required it is assumed that 50 tons of tar per day may be handled in one single unit. This capacity is considered to be the most favourable one with regard to operating conditions as a single plant as well as to the formation of big industrial plants by combining several such separate units. Each unit consists of two reaction towers. In the first one hydrogenation takes place in the liquid phase, while the middle-oils extracted from the first reaction chamber are subjected to hydrogenation in the second tower in the vapour phase in presence of solid catalysts. The reaction pressure is 200 Atm., the reaction conditions being regulated for a yield of petrol and gas only as the final products. In principle, the flow of gases and liquids is the same for all types of hydrogenation plant.

The hydrogen to be used for hydrogenation may contain some 5 to 8% of impurities. The consumption during the process is taken as 8 to 10% of the weight of tar and middle oils put through the reaction vessels. The recovery of hydrogen still contained in the gas leaving the plant is left out of consideration for the calculation of the production costs, because it would only influence them very slightly.

The total costs of the installation are itemized and summarized in Tables I. and II. separately for the high-pressure hydrogenation plant proper and the required auxiliary plants. The figures there comprise the costs of all the equipment necessary to put the plants in a state ready for operation. The capital required for the gas-producing plant and its auxiliaries is not given in Tables I. and II. in order to make allowance for the different ways by which the raw gas may be produced. The hydrogen is assumed to be produced by conversion of carbon monoxide by means of steam. This so-called catalytic water-gas process is the sole source of hydrogen in the large plants of the I.G. Farben as well as of the I.C.I. and will also have to be used with certain modifications in all such cases where hydrogen must be manufactured from methane or other gaseous or liquid hydrocarbons.

TABLE I.

Costs of Installation of the High-Pressure Hydrogenation Plant, Complete and Ready for Operation.

—	German Marks.	£
1.—High-pressure compressors, pumps, and motors	220 000	10,750
2.—Two reaction vessels, complete	170,000	8,320
3.—Furnaces for heating of hydrogen, tar, oils, heat exchangers	260,000	12,720
4.—Pressure vessels, storage vessels, high-pressure coolers, pipes, and valves	210,000	10,260
5.—Electric installation, instruments for measuring and control, &c.	130.000	6,360
6.—Buildings, foundations, cranes tanks	260,000	12,720
7.—Insulation, supports, stages, &c.	70,000	3.430
8.—Low-pressure equipment, gas and water mains, valves, feeding pumps, water-cooling system	190,000	9,290
9.—Repair shops, small spares, sundries	130,000	6,350
Total costs of the high-pressure plant	1,640,000 RM.	£80,200

The proper high-pressure equipment will cost about one million marks (£50,000), excluding spares of higher prices, such as compressors, reaction vessels, &c.

TABLE II.

Costs of Installation of the Auxiliary Plants belonging to the Complete Hydrogenation Unit.

—	German Marks.	£
1.—Gasholders with foundations, boosters, equipment for gas distribution and control	320,000	15,640
2.—Sulphur purification plant with foundation, complete with handling plant for oxide	160,000	7 830
3.—Hydrogen production plant	250,000	12,200
4.—Carbon dioxide absorption plant, including water tanks and water regeneration	170,000	8,320
5.—Interconnecting pipes between the plants for gas, water, steam, oil, foundations, insulation, valves, &c.	90,000	4,400
6.—Boiler plant, distilling plant, complete	100,000	4,880
7.—Workshops, small spares, offices, laboratories, and sundries	160,000	7,830
Total costs of auxiliary plants	1,250,000 RM.	£61,100

The total costs for a complete hydrogenation unit (without the gas plant and its auxiliaries) will be, therefore, about three million marks (£150,000) for a plant designed to handle 50 tons of tar per day.

The costs estimated for a capacity of 150 tons per day would amount to about 8 million marks (£400,000), and for a capacity of 300 tons per day to fifteen million marks (£750,000), favourable site conditions presumed.

Operating and Production Costs in the Hydrogenation Plant.

The operating costs for the proper hydrogenation plant (the high-pressure plant) are calculated in such a manner that for raw gas and hydrogen a price is assumed. The price per cubic metre of hydrogen is fixed for the calculation of Table III. on the assumption that the ordinary catalytic water gas process be employed, and will be varied later according to the source of it. The same applies to the price of tar.

The lifetime of the high-pressure plant is assumed to be 10 years, which for liquid hydrocarbons as raw material is certain to be reached, while it would be considerably less for direct treatment of coal.

The rate of interest and amortization is taken as 15% of the total costs of the high-pressure plant.

For repair and maintenance the calculation is based on 12% of the costs of the hydrogenation plant per year and 6% for the low-pressure equipment.

Motors for compressors and pumps, being electric motors.

Data Used as Basis for the Figures of Table III.

		Shillings.
Costs of energy	2·5 Rpfg./kWh	0·0245
,, steam	3·5 RM./ton (3 atm.)	3·43
,, water	4·0 Rpfg./m³	0·0392
,, gas for heating	1·5 Rpfg./m³	0·0147
,, hydrogen with 1% CO_2	2·8 Rpfg./m³	0·0275
,, tar	45·0 RM./ton	44·10

Furthermore, it is assumed that 7,600 working hours per year be attainable.

The yield of motor spirit over that period is 85% of the original weight of the raw material subjected to hydrogenation.

TABLE III.

Hourly Costs for the Hydrogenation of 50 Tons of Tar a Day (Production Costs of 42·50 Tons of Petrol a Day).

—	RM.	Shillings.
1.—Capital charges	32·50	31·85
2.—Costs of tar	93·50	91·60
3.— ,, hydrogen	84·00	82·30
4.— ,, energy	22·00	21·60
5.— ,, gas for heating	10·00	9·80
6.— ,, cooling water and steam	5·70	5·58
7.—Wages and salaries	16·80	16·47
8.—Cleaning and replacing of catalyst	4·50	4·40
9.—Maintenance, repair, testing	20·90	20·50
10.—Management (75% of item 7)	12·60	12·35
11.—Distilling, refining, chemicals, laboratory services, &c.	26·50	26·00
Hourly costs for working up 50 tons of tar per day	329·00 RM.	322·45s.

This figure does not include wages and charges for handling tar, oil, and petrol within the works, maintenance of buildings, room heating and lighting, general safety precautions, and the many other small expenses required to keep the plants running smoothly.

On the other hand, the credit for gas produced during the reaction would have to be considered in order to calculate the price per gallon motor spirit, free, *ex* works.

It is rather difficult, however, to give general figures for these two items, as they depend on a great many circumstances varying with the site conditions and the possibility of using the gas in the works or of selling it wholly or partly more advantageously. If the calorific value of the gas is used, approximately 25 to 30 RM. would be obtainable for it. At least the same amount would have to be spent for the expenses mentioned above. Thus it should be justifiable to presume that these two items compensate one another.

Table III. shows clearly the fact that the production price of petrol depends in the first place upon the prices of hydrogen and tar. Here the price per cubic metre of hydrogen was taken at 2·8 Rpfg. (0·0275s.) and that per ton of tar at 45 RM. (44·1s.).

In order to demonstrate to what extent other prices for tar and hydrogen would influence the costs of petrol, in Tables IV. and V. the price of tar as well as that of hydrogen are varied in a wide range.

TABLE IV.

Costs per Litre and per Gallon of Motor Spirit depending on the Price of Hydrogen, Price of Tar being 45 RM. per Ton (44·1s.).

—	One M³ of Hydrogen Costs—			Costs of Motor Spirit—	
	Rpfg.	s.	d.	Rpfg. per Litre.	d. per Gall.
1.	2·8	0·0275	0·330	14·10	7·55
2.	3·5	0·0343	0·412	15·00	8·02
3.	4·5	0·0441	0·530	16·30	8·72
4.	6·0	0·0588	0·706	18·30	9·79
5.	8·0	0·0785	0·942	20·80	11·10

TABLE V.

Costs per Litre and per Gallon of Motor Spirit depending on the Price of Tar, Price of Hydrogen being 2·8 Rpfg. per M³ (0·33d.).

—	One Ton of Tar Costs—		Costs of Motor Spirit—	
	Reichmarks.	s.	Rpfg. per Litre.	d. per Gall.
1	35	34·3	13·3	7·10
2	45	44·1	14·1	7·55
3	55	53·9	15·1	8·07
4	65	63·7	16·0	8·55
5	75	73·5	16·9	9·04

Economics.

As mentioned before, for the comparison of the production costs of synthetic motor spirit with imported petrol, German conditions are considered.

At present the prices for various sorts of tar are as follows: Low temperature tar from brown coal costs 60 to 70 RM. per ton, the cheapest sorts of tar 25 to 30 RM., while coke oven tar costs 42 to 45 RM. per ton free at works without charges for packing. Assuming that a mixture of various brown-coal tars be subjected to hydrogenation, the price per ton of tar stored in the feed tanks of the hydrogenation plant will be about 55 RM. We shall use this figure in connection with the price of 2·8 Rpfg. per m³ of hydrogen for the following considerations, both these figures representing a good average of the practical conditions in commercial operation.

From Table V. it is to be seen that in these circumstances the price per litre of synthetic motor spirit is 15·10 Rpfg. (8·07d. per gallon).

This price, however, has to be taken as the *minimum* production cost, because it does not comprise a number of items not really belonging to the hydrogenation plants but always connected with them—*e.g.*, patent charges, scientific research work, installation of experimental plants, &c. Moreover, the working time of 7,600 hours per annum will scarcely be reached, and the costs for starting up the plants, for temporary shut-downs, and re-starting are also not included in the above figure. And, last but not least,

the assumed average yield of 85% of the weight of raw material will not easily be attained over a period of 7,600 working hours.

Let us now compare the costs of synthetic motor spirit with those of imported motor spirit of "natural" origin.

During the last few years the price of imported petrol has changed considerably, as is shown in Table VI.

TABLE VI.

The price per litre and per gallon of motor spirit c i.f. Hamburg was—

1.1.1930.	13·43 Rpfg./litre	..	7·18d. per gallon
1.5.1930.	12·81	,,	.. 6·85d. ,,
15.6.1931.	5·11	,,	.. 2·74d. ,,
10.9.1932.	5·48	,,	.. 2·94d. ,,
1.9.1935.	5·59	,,	.. 2·99d. ,,

(The figures are taken from an article in *Erdöl and Teer*, 25.9.1932.)

This Table demonstrates the well-known fact that since 1931 the price of petrol has dropped to an unexpected low level due to the world economic crisis, while before that time the price of imported petrol was well commensurate with that of synthetic motor spirit. At the time where the first commercial plants were being started to work the economic aspect of hydrogenation was a rather favourable one inasmuch as only a small preference of tax over imported petrol would have made hydrogenation profitable so long as the price of imported petrol kept its level, while only a small rise would have made this support of the Government superfluous.

Whether this optimistic view in regard to the future was really justifiable will not be discussed here.

Actually, prices have dropped to less than half of those in 1930 and remained fairly steady at that level up to the present. It is obvious that at present synthetic petrol could never compete with imported petrol without the support of the Government, the share of which in Germany is not made known to the public but is computable with some degree of accuracy.

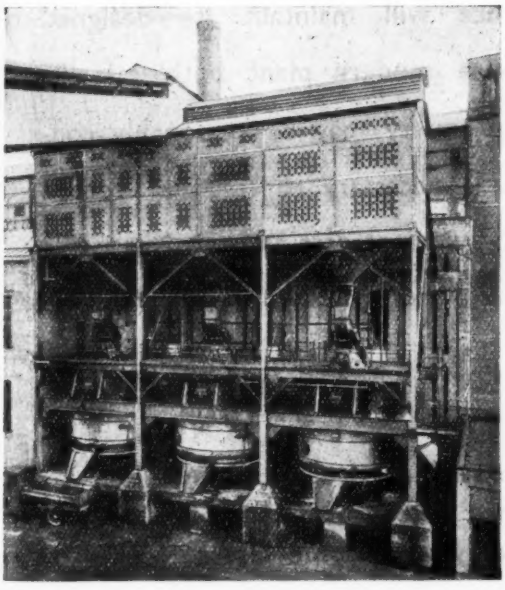
If we take the figure of 5·59 Rpfg./ltr. (2·99d. per gallon) in September, 1935, and keep in mind that the duty for imported motor spirit since 1931 is 16·23 Rpfg./ltr. (8·68d. per gallon), the basis of calculation for importers of foreign petrol would have to be 21·82 Rpfg. per litre (11·7d. per gallon), and in order to give the hydrogenation works the same chance this price would have to be guaranteed by the Government. This means that at present the tax per litre of synthetic petrol would be 6·72 Rpfg. (3·6d. per gallon) instead of 16·23 Rpfg./ltr. (8·68d. per gallon). In other words, the preference on home-produced petrol over imported petrol would have to be about 10 Rpfg./ltr. (5·35d. per gallon).

Emphasis must be laid, however, upon the fact that these considerations are being based on the minimum production costs, so that the real preference guaranteed by the Government will amount to some 12 to 13 Rpfg. per litre of home-made petrol (6·41d. to 6·95d. per gallon).

In England the Government guarantees at present a preference of 8d. a gallon, which means that synthetic petrol is actually duty-free over a maximum period of 4½ years. (This figure fits quite well in the picture drawn above for German conditions.) Whether it will be possible in the course of time to reduce this preference on a sliding scale in order to extend the preference over a longer period—as provided for by the British Hydrocarbon Oils Production Bill—will depend on the development of prices for imported petrol and future improvements in relation to the economics of the process itself. In this connection the efforts to combine hydrogenation with a suitable cracking process seem to gain ground.

At the present time only protective measures of the Governments of the various countries keep hydrogenation alive, and this—it seems to me—in the first place because of its enormous military importance for countries without sufficient natural sources and in connection with schemes to diminish unemployment.

GAS PRODUCER PLANTS



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May we send particulars of the Simmance Patent Gravitometer and refer you to some Users?

ALEXANDER WRIGHT & Co. LTD. WESTMINSTER

Gas Markets and Manufactures

Stock Market Report

(For Stock and Share List, see later page)

International affairs were again the crux of the situation last week and led to a reactionary tendency in most markets, while despite large over-subscriptions some of the latest new issues commenced dealings at a discount. A feature was the set-back in New Zealand stocks following the election of a Labour Government in the Dominion. There was one bright spot—the Home Rail Market—which was given a fillip by the latest traffic returns and the London Midland and Scottish 4% preference dividend announcement.

The Gas Market fared little better than other sections in the volume of business, which was confined mainly to the stocks of the larger companies. There were no special features, and it will be seen in the Stock and Share List that quotations for the most part remained unchanged, the only movement of note being a further drop of 5 points in Imperial Continental to 180. Dealings began in the United Kingdom Gas Corporation's latest issues of ordinary and preference shares at a small discount.

The Watford and St. Albans Gas Company's stocks are now officially quoted on the London Stock Exchange and have, therefore, been added to the "JOURNAL" List. The ordinary stock, on which a dividend of 6¾% has been paid since 1930, is quoted at 149-154, at which price the yield works out at £4 9s. 1d.%.

Current Sales of Gas Products

The London Market for Tar Products.

Dec. 2.

There are a few changes to report in the Tar Products Market, prices being at about the following levels:

Sales of pitch are reported at 40s. per ton f.o.b.

Creosote is steady at 5¾d. per gallon.

Refined tar, 4d. per gallon in bulk at makers' works.

Pure toluole 2s. 9d. to 2s. 10d.; pure benzole, 1s. 7d. to 1s. 8d.; 95/160 solvent naphtha, 1s. 7d. to 1s. 8d.; and 90/160 pyridine, about 4s. 9d.—all per gallon naked at makers' works.

Tar Products in the Provinces.

Dec. 2.

The average prices of gas-works products during the week were: Gas-works tar, 21s. 6d. to 26s. 6d. Pitch—East Coast, 37s. 6d. to 40s. f.o.b. West Coast—Manchester, Liverpool, Clyde, 37s. 6d. to 40s.* Toluole, naked, North,, 2s. to 2s. 2d. Coal-tar crude naphtha, in bulk, North, 7½d. to 7¾d. Solvent naphtha, naked, North, 1s. 5½d. to 1s. 6d. Heavy naphtha, North, 11½d. to 1s. Creosote, *ex* works, in bulk, North, liquid and salty, 4⅞d. to 5d.; low gravity, 4¾d. to 4⅞d.; Scotland, 4¾d. to 4⅞d. Heavy oils, in bulk, North, 4¾d. to 5d. Carbolic acid, 60's, 2s. 1d. to 2s. 2d. Naphthalene, £13 to £15. Salts, 65s. to 70s. bags included. Anthracene, "A" quality, 2½d. to 3d. per minimum 40%, purely nominal; "B" quality, unsalable.

* All prices for pitch are now quoted on the basis of f.o.b. In order to arrive at the f.a.s. value at any port it will be necessary to deduct the loading costs and the tolls whatever they may be.

Tar Products in Scotland.

GLASGOW, *Nov.* 30.

There is still great interest being taken in the finer products and prices are firm.

Crude gas-works tar.—The actual value is 27s. to 29s. per ton *ex* works in bulk.

Pitch.—Stocks have diminished in this area and current value is 32s. 6d. to 35s. per ton f.o.b. Glasgow for export and 32s. 6d. per ton *ex* works in bulk for home trade.

Refined tar continues to be offered at 2½d. to 2¾d. per gallon, f.o.b. naked, but actual business is not plentiful.

Creosote oil.—Production is well looked after and the following may be taken as about average prices: B.E.S.A. Specification, 5⅛d. to 5⅜d. per gallon; low gravity, 5¼d. to 5½d. per gallon; and neutral oil, 5¼d. to 5½d. per gallon; all f.o.r. in bulk.

Cresylic acid.—There is little or no quantity now available in this area and prices are therefore nominal as follows: Pale, 97/99%, 1s. 4d. to 1s. 4½d. per gallon; dark, 97/99%, 1s. 2d. to 1s. 2½d. per gallon; and pale, 99/100%, 1s. 4d. to 1s. 5d. per gallon; all *ex* works naked.

Crude naphtha.—The value of this is steady at 5d. to 5½d. per gallon, according to quality and district.

Solvent naphtha.—90/160 grade is 1s. 4d. to 1s. 4½d. per gallon, and 90/190 heavy naphtha is 11½d. to 1s. per gallon.

Motor benzole is not lower than 1s. 3½d. to 1s. 4d. per gallon in bulk at makers' works.

Pyridines.—90/160 grade is 5s. 6d. to 6s. per gallon, and 90/140 grade is 6s. to 6s. 6d. per gallon.

Benzole Prices.

These are considered to be the market prices for benzole at the present time:

	s.	d.		s.	d.	
Crude benzole	0	9½	to	0	10	per gallon at works
Motor ,,	1	3	,,	1	3½	,, ,, ,,
90% ,,	1	4	,,	1	4½	,, ,, ,,
Pure ,,	1	7½	,,	1	8	,, ,, ,,

Contracts Advertised To-Day

Benzole Plant.

Abertillery Gas Department. [p. 736.]

Boilers (Waste Heat).

Abergavenny Gas Department. [p. 734.]
Abertillery Gas Department. [p. 734.]

Chamber Ovens, &c.

Abertillery Gas Department. [p. 784.]

Coke Screening, &c., Plants.

Abergavenny Gas Department. [p. 734.]
Abertillery Gas Department. [p. 734.]

Gasholders, &c.

Abergavenny Gas Department. [p. 734.]
Abertillery Gas Department. [p. 736.]

Mechanical Shovel.

Abertillery Gas Department. [p. 736.]

Storage Bunkers.

Abergavenny Gas Department. [p. 734.]

Vertical Retort Plant.

Abergavenny Gas Department. [p. 734.]

Trade Notes

Parkinson & Cowan (Gas Meters), Ltd.

We learn that Mr. Eric Mitchell, a member of the staff of the Glasgow Branch of Messrs. Parkinson & Cowan (Gas Meters), Ltd., who is leaving to take up a post in the North of England Branch of the Company, has been presented with a testimonial from the members of the staff and workers. The presentation was made by the Manager, Mr. F. J. R. Forsyth, who, in his remarks paid a tribute to Mr. Mitchell and wished him every success and prosperity in his new post. Mr. Mitchell suitably replied and thanked the workers and staff for their good wishes for his future welfare and prosperity.

Thomas Gas Meters for Rotherham Coke-Oven Plant.

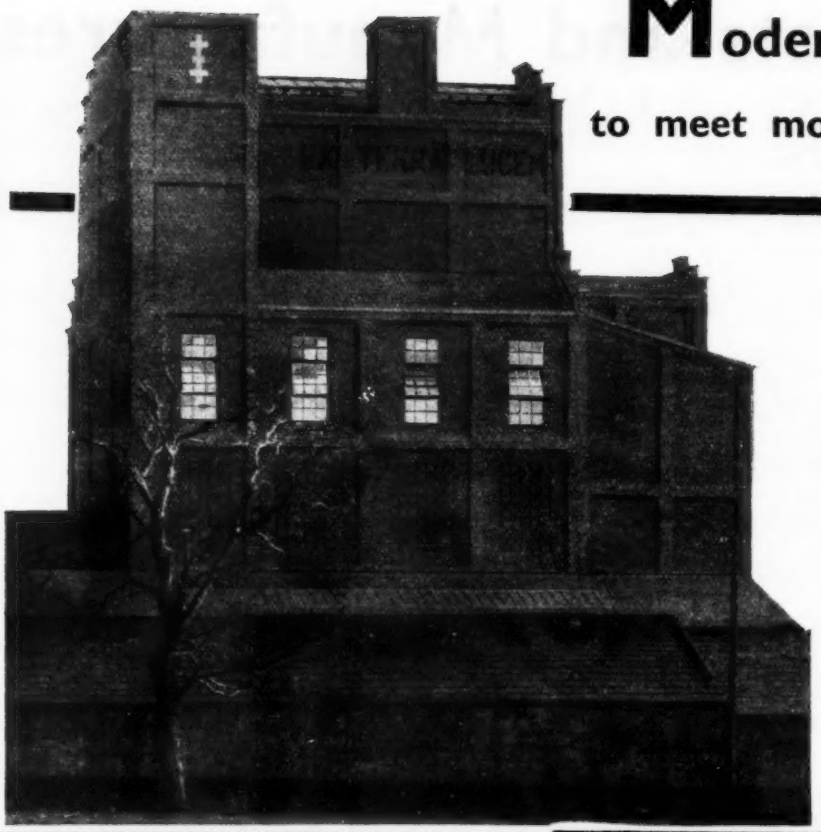
The new coke ovens erected in connection with the Orgreave by-product plant of the Rothervale Collieries, which are owned by the United Steel Companies, Ltd., of Sheffield, are being equipped with three Thomas gas meters constructed by the Cambridge Instrument Company, Ltd., of 45, Grosvenor Place, S.W. 1. One meter for measuring the producer gas supplied for heating the coke ovens will have a maximum capacity of 800,000 cu.ft. per hour, with meter housing 24 in. diameter. The second meter, for the coke oven gas delivered to the gas-holder, will have a capacity of 500,000 cu.ft. per hour, with housing 20 in. diameter, and the third meter, for surplus coke oven gas used in the coke ovens, will have a capacity of 300,000 cu.ft., with housing 16 in. diameter.

Overseas Opportunities

New Delhi.

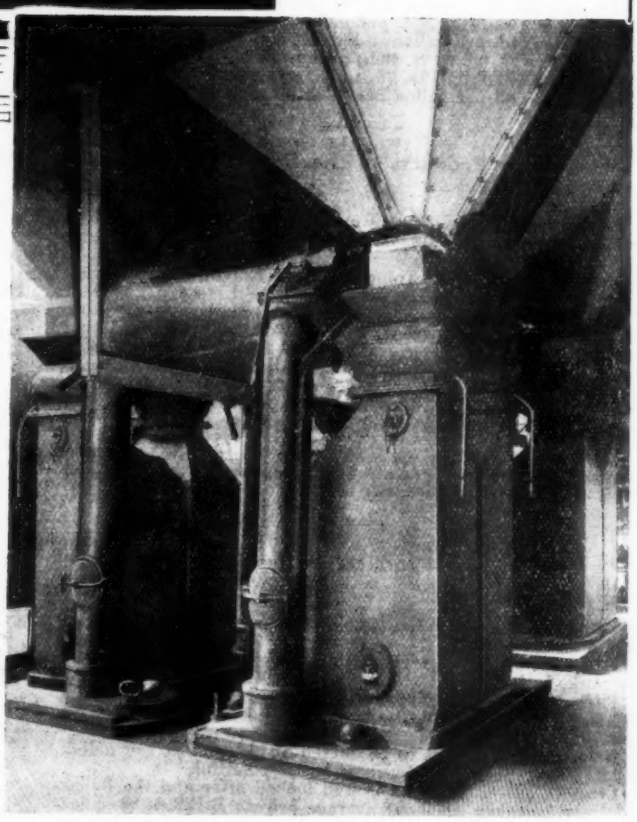
H.M. Trade Commissioner at Calcutta reports that the Indian Stores Department is calling for tenders, to be presented in New Delhi by Jan. 16, 1936, for the supply and delivery, under an annual rate contract, of cast-iron pipes and specials to B.S.I. Specification No 78, Current Edition. (Ref. T.Y. 5,514.)

Modern methods
to meet modern demands . . .



THE WEST SYSTEMS

GLOVER - WEST vertical retorts of modern design are here shown in service at the works of the Yeadon & Guiseley Gas Company. More than 380 installations have been or are being constructed.



- GLOVER-WEST VERTICAL RETORTS
- WESTVERTICAL CARBONIZING CHAMBERS
- THE WEST FUEL-HANDLING SYSTEMS

WEST'S GAS IMPROVEMENT COMPANY, LTD.

MANCHESTER: Albion Ironworks, Miles Platting
'Phone: COLLYHURST 2961 : 'Grams: "STOKER, MANCHESTER"

LONDON: Columbia House, Aldwych, W.C.2
'Phone: HOLBORN 4108 : 'Grams: "WESGASCO, ESTRAND, LONDON"

MEMBERS OF THE SOCIETY OF BRITISH GAS INDUSTRIES

STOCK AND SHARE LIST

Official Quotations on the London and Provincial Stock Exchanges

Issue. £	Share	When ex-Dividend.	Dividends. Prev. Hf. Yr % p.a.	Dividends. Last Hf.Yr. % p.a.	NAME.	Quotations Nov. 29.	Rise or Fall on Week.	Transactions, Lowest and Highest of Week.
1,551,868	Stk.	Sept. 9	7	7	Alliance & Dublin Ord. ...	130—140	...	...
374,000	,,	June 24	4	4	Do. 4 p.c. Deb. ...	97—102	...	...
557,655	,,	Aug. 12	7	7	Barnet Ord. 7 p.c.	165—170	...	...
300,000	1	Oct. 7	1/9⅓	1.4½	Bombay, Ltd.	1 5/16—1 7/16	...	26/6
178,480	Stk.	Aug. 12	9⅓	9⅓	Bournemouth sliding scale ...	222—232	...	...
550,050	,,	,,	7	7	Do. 7 p.c. max. ...	168—173	...	...
489,160	,,	,,	6	6	Do. 6 p.c. Pref. ...	147—152	...	...
50,000	,,	June 24	3	3	Do. 3 p.c. Deb. ...	83—88	...	...
262,025	,,	,,	4	4	Do. 4 p.c. Deb. ...	105—110	...	...
335,000	,,	,,	5	5	Do. 5 p.c. Deb. ...	123—128	...	...
357,900	,,	Aug. 12	7½	7½	Brighton, &c., 6 p.c. Con. ...	170—175	...	173
649,955	,,	,,	6½	6½	Do. 5 p.c. Con. ...	156—161	...	...
205,500	,,	,,	6	6	Do. 6 p.c. B. Pref.	142—147	...	147
1,487,500	,,	July 8	5	5	Bristol, 5 p.c. max.	118—120a	...	...
120,420	,,	June 7	4	4	Do. 1st 4 p.c. Deb. ...	102—104a	...	...
217,870	,,	,,	4	4	Do. 2nd 4 p.c. Deb. ...	101—103a	...	...
328,790	,,	,,	5	5	Do. 5 p.c. Deb.	127—130a	...	...
855,000	,,	Sept. 23	8	7	British Ord.	152—157	...	...
100,000	,,	June 7	7	7	Do. 7 p.c. Pref.	155—160	...	...
350,000	,,	,,	5½	5½	Do. 5½ p.c. "B" Cum. Pref.	112—117	...	...
120,000	,,	,,	4	4	Do. 4 p.c. Red. Deb. ...	99—103	+3½	...
450,000	,,	,,	5	5	Do. 5 p.c. Red. Deb. ...	109—114	...	...
200,000	,,	,,	...	17/6§	Do. 3½ p.c. Red. Deb. ...	99—101	...	...
100,000	10	22 May '33	6	4	Cape Town, Ltd.	1—3	...	...
100,000	10	6 Nov.'33	4½	4½	Do. 4½ p.c. Pref. ...	1—3	...	...
150,000	Stk.	June 24	4½	4½	Do. 4½ p.c. Deb. ...	83—88	...	...
626,860	,,	July 22	6	6	Cardiff Con. Ord.	127—132	...	...
157,150	,,	Aug. 12	6½	5	Chester 5 p.c. Ord.	109—114b	...	...
98,936	1	Sept. 23	2/-	2/-	Colombo, Ltd., Ord.	1⅜—1⅝	...	...
24,500	1	,,	1/4⅛	1/4⅛	Do. 7 p.c. Pref. ...	20/-—22/-	...	...
609,204	1	Oct. 7	-/11·48	-/11·48	Colonial Gas Assn. Ltd. Ord.	19/6—21/6	...	...
296,053	1	,,	1/3 30	1/3 30	Do. 8 p.c. Pref.	24/6—26/6	...	...
1,775,005	Stk	Aug. 12	6	5	Commercial Ord.	100—105	...	102—104½
620,000	,,	June 7	3	3	Do. 3 p.c. Deb. ...	82—87	...	86½
286,344	,,	Aug. 12	5	5	Do. 5 p.c. Deb. ...	121—126	...	123¾—124½
807,560	,,	Aug. 12	7	7	Croydon sliding scale... ...	151—156	...	154½
569,590	,,	,,	5	5	Do. max. div.	113—118	...	115—116
620,385	,,	June 24	5	5	Do. 5 p.c. Deb. ...	123—128	...	...
542,270	,,	Aug. 12	10	7	Derby Con.	175—185c	...	...
55,000	,,	June 24	4	4	Do. 4 p.c. Deb.	100—105c	...	...
239,000	,,	Aug. 12	5	5	East Hull Ord. 5 p.c.	109—112	...	...
181,625	,,	Aug. 12	6	6	East Surrey Ord 5 p.c. ...	129—134	...	...
175,609	,,	June 7	5	5	Do. 5 p.c. Deb. ...	120—125	...	...
19,313,481	,,	Aug. 12	5½	5½	Gas Light & Coke 4 p.c. Ord.	27 6—28 6f	...	27/7½—28/3
2,600,000	,,	,,	3½	3½	Do. 3½ p.c. max.	88—91	...	89½—91
4,477 106	,,	,,	4	4	Do. 4 p.c. Con. Pref. ...	105—108	...	106½—108
8,602,497	,,	June 7	3	3	Do. 3 p.c. Con. Deb. ...	89—92	+1	90¼—91½
3,642,770	,,	,,	5	5	Do. 5 p.c. Red. Deb. ...	115—118	...	...
3,500,000	,,	,,	4½	4½	Do. 4½ p.c. Red. Deb. ...	112—115	...	112—114½
270,466	,,	Aug. 12	6	6	Harrogate New Cons. ...	132—137	...	...
140,000	1	Sept. 23	1/7½	1/7½	Hongkong & China, Ltd. ...	1½—1¾	...	...
213,200	Stk.	Aug. 12	6	6	Hornsey Con. 3½ p.c.... ...	130—135	...	...
5,600,000	,,	Nov. 4	14	8	Imperial Continental Cap. ...	175—185	−5	175—184
223,130	,,	July 22	3½	3½	Do. 3½ p.c. Red. Debs.	92—97	...	...
285,242	,,	Aug. 12	8½	8½	Lea Bridge 5 p.c. Ord. ...	175—180	...	...
2,167,410	,,	Aug. 12	6	6	Liverpool 5 p.c. Ord.... ...	133—135b	...	...
245,500	,,	June 7	5	5	Do. 5 p.c. Red. Pref. ...	105—110b	...	...
306,083	,,	July 8	4	4	Do. 4 p.c. Deb.... ...	105—107b	...	...
165,736	,,	Aug. 26	10	8	Maidstone 5 p.c. Cap. ...	182—192	...	...
63,480	,,	June 24	3	3	Do. 3 p.c. Deb. ...	80—85	...	...
75,000	,,	May 27	†10	†10	Malta & Mediterranean ... Metropolitan (of Melbourne)	210—220	...	...
392,000	—	Oct. 1	5½	5½	5½ p.c. Red. Deb.	98—103	...	...
231,978	Stk.	Aug. 12	5	5	M. S. Utility "C" Cons. ...	108—113	...	...
818,657	,,	,,	4	4	Do. 4 p.c. Cons. Pref.	100—105	...	103¾—104½
360,075	,,	June 24	4	4	Do. 4 p.c. Deb. ...	102—107	...	...
148,955	,,	,,	5	†5	Do. 5 p.c. Deb. ...	120—125	...	...
125,000	—	July 1	3½	3½	Do. 3½ p.c. Rd. Rg. Bds.	97—100	...	...
675,000	,,	Nov. 18	†3	†3	Montevideo, Ltd.	48—53*	...	48½—49½
2,061,315	,,	Aug. 12	5½	5	Newcastle & Gateshead Con.	25/9—26 3df	...	...
682,856	,,	,,	4	4	Do. 4 p.c. Pref. ...	107—108d	...	...
776,706	,,	June 7	3½	3½	Do. 3½ p.c. Deb. ...	100—102d	...	...
277,285	,,	Oct 21	5	5	Do. 5 p.c. Deb. '43 ...	105—106d	...	...
274,000	,,	Aug. 12	5	5	Newport (Mon.) 5 p.c. max....	113—118a	...	...
225,000	,,	Aug. 12	7½	7½	North Middlesex 6 p.c. Con.	165—175	...	175
396,160	,,	Aug. 12	5	5	Northampton 5 p.c. max. ...	105—110	...	...
300,000	,,	Nov. 4	†7	†9	Oriental, Ltd.	163—168*	...	...
416,617	,,	June 7	8	8	Plym'th & Stonehouse 5 p.c.	162—167	...	...
504,416	,,	Aug 12	8½	8½	Portsm'th Con. Stk. 4 p.c. Std.	172—177	...	...
241,446	,,	,,	5	5	Do. 5 p.c. max. ...	110—115	...	...
114,000	,,	July 22	5	5	Preston 5 p.c. Pref.	106—111	...	...
321,961	1	Sept. 23	...	1/-	Severn Val. Gas Cor. Ld. Ord.	22 3—23/3	...	22/3—22/6
319,510	1	,,	...	-/10½	,, ,, 4½ p.c. Cum. Pref.	21 9—22/9	...	...
1,736,968	Stk.	Aug. 26	6	6	Sheffield Cons.	140—142e	...	...
95,000	,,	June 24	4	4	Do. 4 p.c. Deb.	102—104e	...	...
133,201	,,	Aug. 12	5	8½	Shrewsbury 5 p.c. Ord. ...	135—140	...	...
90,000	10	May 27	‡3	‡3½	South African	3—4	...	...
1,061,779	1	Sept. 23	1/2‡	1/2‡	South East'n Gas Cn. Ld. Ord.	27/6—28/6	...	27/6—28/6
845,016	1	,,	-/10½	-/10½	Do. 4½ p.c. Red. Cum. Pref.	22/3—23/3	...	22/-
450,000	Stk.	Aug. 12	4	4	Do. 4 p.c. Red. Deb. ...	100—103	...	...
6,709,895	,,	Aug 12	6½	5	South Met. Ord.	132—137	−1	132—135½
1,135,812	,,	,,	6	6	Do. 6 p.c. Irred. Pf. ...	147—152	...	...
850,000	,,	,,	4	4	Do. 4 p.c. Irred. Pf. ...	105—109	...	106
1,895,445	,,	June 24	3	3	Do. 3 p.c. Deb. ...	86—91	...	89
1,000,000	,,	July 8	5	5	Do. 5 p.c. Red. Deb....	115—118	...	115½
209,820	,,	Aug. 12	8½	8½	South Shields Con.	171—173d	...	...
1,543,795	,,	Aug. 12	6	6	South Suburban Ord 5 p.c. ...	128—133	...	131—132
512,825	,,	,,	5	5	Do. 5 p.c. Pref. ...	121—126	+3	123½—126
500,000	,,	,,	4	4	Do. 4 p.c. Pref. ...	103—108	...	105—106
888,587	,,	June 7	5	5	Do. 5 p.c. Deb. ...	122—127	...	...
250,000	,,	,,	4	4	Do. 4 p.c. Deb. ...	103—108	...	...
647,740	,,	Aug. 12	5	5	Southampt'n Ord. 5 p.c. max.	115—120	...	117½
121,275	,,	June 7	4	4	Do. 4 p.c. Deb.	100—105	...	...
350,000	,,	Aug. 12	5½	5½	Swansea 5½ p.c. Red. Pref. ...	112—117	...	...
200,000	,,	June 7	6½	6½	Do. 6 p.c. Red. Deb. ...	98—103	...	...
94,600	,,	,,	...	...	Do. 3½ p.c. Red. Deb. ...	97—102	...	...
1,076,490	,,	Aug. 12	6⅔	6⅔	Tottenham and District Ord.	149—154	...	152
409,835	,,	,,	5⅔	5⅔	Do. 5½ p.c. Pref. ...	130—135	...	...
62,235	,,	,,	5	5	Do. 5 p.c. Pref. ...	117—122	...	...
334,615	,,	June 7	4	4	Do. 4 p.c. Deb. ...	101—106	...	...
369,774	,,	Aug. 12	7	7	Uxbridge, &c., 5 p.c.	151—156	...	154
108,330	,,	,,	5	5	Do. 5 p.c. Pref. ...	117—122	...	...
1,340,521	,,	Aug. 12	7	7	Wandsworth Consolidated ...	157—162	...	160—161½
1,371 373	,,	,,	5	5	Do. 5 p.c. Pref. ...	118—123	...	121½—123½
1,317,964	,,	June 7	5	5	Do. 5 p.c. Deb. ...	123—128	...	...
338,300	,,	,,	4	4	Do. 4 p.c. Deb. ...	104—109	...	...
499,735	,,	July 8	6¾	6¾	Watford and St. Albans Ord.	149—154	...	...
200,000	,,	,,	5	5	Do. 5 p.c. Pref. ...	117—122	...	...
200,000	,,	,,	5½	5½	Do. 5½ p.c. Pref. ...	135—140	...	...
200,000	,,	June 7	4	4	Do. 4 p.c. Red. Deb.	99—104	...	...
100,000	,,	...	...	...	Do. 3½ p.c. Red. Deb.	97—102	...	...
158,400	,,	Aug. 12	6g	5	Winchester W.& G. 5 p.c. Con.	114—119	...	...

Quotations at :—*a.*—Bristol. *b.*—Liverpool. *c.*—Nottingham. *d.*—Newcastle. *e.*—Sheffield. *f.*—The quotation is per £1 of Stock. *g.*—Paid £3, including 10s. on account of back dividends. * Ex. div. † Paid free of income-tax. ‡ For year. § Actual for three months.

COMPANY NOTICES.

WINCHESTER WATER AND GAS COMPANY.

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By order of the Board,
W. D. WALKER,
Secretary.

90, High Street,
Winchester,
Dec. 4, 1935.

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by

R. N. LeFevre, M.Inst.Gas E.

Officer-in-Charge of Training, The Gas Light and Coke Company. Assistant Head of Department of Gas Engineering and Supply, Westminster Technical Institute.

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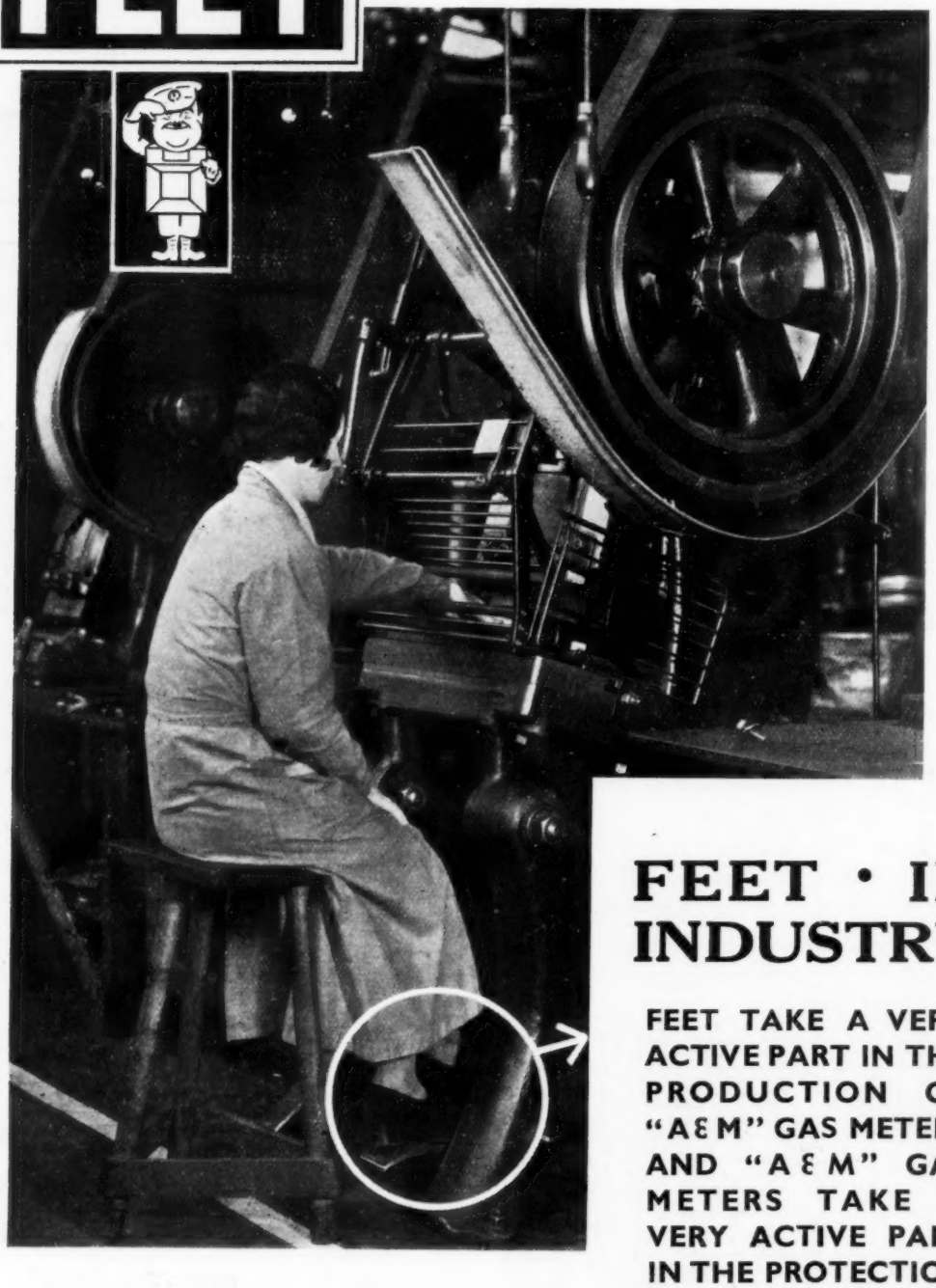
FEET



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